



United States
Department of
Agriculture

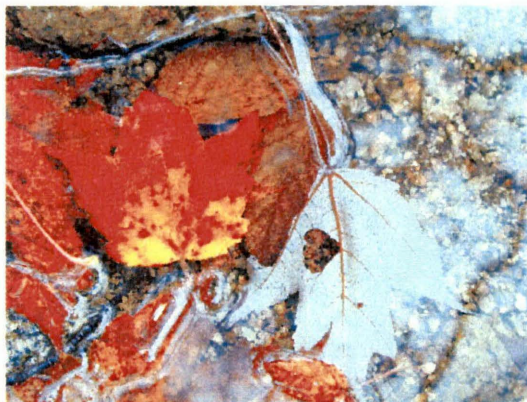
Forest Service

Northeastern
Research Station



Research Attainment Report

Fiscal Year 2001



RESEARCH ATTAINMENT REPORT

FISCAL YEAR 2001

**United States Department of Agriculture
Forest Service
Northeastern Research Station**

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**PART I: RESEARCH WORK UNIT
ATTAINMENT REPORTS**

INTRODUCTION

The Research Work Unit Attainment Reports in Part I each begin with a Research Work Unit Summary. This summary is in the form of a table, listing the problem number and title, the current level of funding, the current staffing (scientist years) and a tally of the number of publications produced, whether in the work unit, through extramural research, or through cooperative research.

The Research Work Unit Summary is followed by further information for each problem giving the attainments for a single problem. These reports give bibliographic information on each publication resulting from the research on a particular problem, plus a narrative summary of the attainment for that problem.

Part II is a bibliography of all the publications produced as a result of research conducted by the Northeastern Research Station in Fiscal Year 2001, listed in alphabetical order.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4103

The Role of Environmental Stress on Tree Growth and Development
Tyree, Melvin T, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Unit	Research Outputs	
				Extramural	Cooperative
1. Measure physiological performance of trees following stress and evaluate mechanisms leading to health declines.	607	2	14	0	0
2. Towards a better understanding of water-stress physiology; hydraulic sufficiency of stems to conduct water to leaves.	304	1	4	1	0

NORTHEASTERN RESEARCH STATION
Research Unit NE-4103

Problem 1 Measure physiological performance of trees following stress and evaluate mechanisms leading to health declines.

Publications

- Research** Borer, Catherine; Schaberg, Paul G.; DeHayes, Donald H.; Hawley, Gary J. 2001. Physiological implications of anthropogenic environmental calcium depletion. In: Labrecque, Michel, ed. 2000 the tree: proceedings of the 4th international symposium on trees; 2000 August 20-25; Montreal, PQ. Montreal, PQ: Isabelle Quentin Press: 295-300.
- DeHayes, D.H.; Jacobson, G.L.; Schaberg, P.G.; Bongarten, B.; Iverson, L.; Dieffenbacher-Brall, A.C. 2001. to changing climate: lessons from the past and uncertainty for the future. In: Mickler, R.A.; Birdsey, R.A.; Hom, J., comps., eds. Responses of northern U.S. forests to environmental change. Ecol. Stud. 139. New York, NY: Springer-Verlag: 495-540.
- DeHayes, D.H.; Schaberg, P.G.; Strimbeck, G.R. 2001. Red spruce (*Picea rubens* Sarg.) cold hardiness and freezing injury susceptibility. In: Bigras, F.J.; Colombo, S.J., comps., eds. Conifer cold hardiness. Dordrecht, The Netherlands: Kluwer Academic Publishers: 495-529.
- Perkins, T.D.; Wong, B.L.; Wilmot, T.R.; Bagget, K.L. 2000. Ice storm effects on stem and root carbohydrate reserves. In: Proceedings of ice storm 1998 forest research conference, program and abstracts; 2000 October 19-22; Ottawa, ON. Toronto, ON: Ontario Ministry of Natural Resources: 123. Poster abstract.
- Perkins, T.D.; Wong, B.L.; Wilmot, T.R.; Bagget, K.L. 2000. Ice storm effects on stored carbohydrates in sugar maple. In: Perkins, T.D., ed. Proceedings of the Maple 2000 conference, International Maple Syrup Institute and North American Maple Syrup Council annual meetings; 2000 October 25-28; Burlington, VT. Underhill Center, VT: The University of Vermont, Proctor Maple Research Center: 16. Poster abstract.
- Schaberg, P.G. 2000. Winter photosynthesis in red spruce (*Picea rubens* Sarg.): limitations, potential benefits, and risks. Arctic, Antarctic, and Alpine Research. 32(4): 375-380.
- Schaberg, P.G.; DeHayes, D.H. 2000. Physiological and environmental causes of freezing injury in red spruce. In: Mickler, R.A.; Birdsey, R.A.; Hom J., comp., eds. Responses of northern U.S. forests to environmental change. Ecol. Stud. 139. New York, NY: Springer-Verlag: 181-227.
- Schaberg, P.G.; DeHayes, D.H.; Hawley, G.J.; Murakami, P.F. 2000. Does acid rain contribute to maple decline? In: Maple 2000; 2000 October 25-28; Burlington, VT; Underhill Center, VT: University of Vermont, Proctor Maple Research Center: 14. Abstract.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4103

- Research** **Schaberg, Paul G.; Murakami, Paula F.; Lazarus, Brynne E.; DeHayes, Donald H.; Hawley, Gary J.; Borer, Catherine H. 2001. Membrane-associated calcium: a source of signal calcium in woody plants? In: Bush, D.R., ed. Plant biology 2001: proceedings of the quadrennial joint meeting of the American Society of Plant Biologists and the Canadian Society of Plant Physiologists; 2001 July 21-25; Providence, RI. Rockville, MD: American Society of Plant Physiologists: 48. Poster abstract.**
- van den Berg, Abby K.; Donnelly, John R.; Murakami, Paula F.; Schaberg, Paul G. 2001. Development of fall foliage color in sugar maple. In: Labrecque, Michel, ed. 2000 the tree: proceedings of the 4th international symposium on trees; 2000 August 20-25; Montreal, PQ. Montreal, PQ: Isabelle Quentin Press: 356-360.**
- van der Berg, A.; Donnelly, J.R.; Murakami, P.F.; Schaberg, P.G. 2000. Fall foliage color development in sugar maple. In: Maple 2000; 2000 October 25-28; Burlington, VT. Underhill Center, VT: University of Vermont, Proctor Maple Research Center: 13. Abstract.**
- Wong, B.L.; Baggett, K.L.; Burfiend, A.J.; Rye, S.H. 2000. Starch and soluble sugar levels during the leafless period in sugar maples with crown dieback. In: Perkins, T.D., ed. Proceedings of the Maple 2000 conference, International Maple Syrup Institute and North American Maple Syrup Council annual meetings; 2000 October 25-28; Burlington, VT. Underhill Center, VT: The University of Vermont, Proctor Maple Research Center: 15. Poster abstract.**
- Wong, B.L.; Baggett, K.L.; Rye, A.H.; Burfiend, A.S.; Staats, L.J. 2000. Fall/winter carbohydrate reserves in sugar maples after the January 1998 ice storm in northern New York. In: Perkins, T.D., ed. Proceedings of the Maple 2000 conference, International Maple Syrup Institute and North American Maple Syrup Council annual meetings; 2000 October 25-28; Burlington, VT. Underhill Center, VT. The University of Vermont: Proctor Maple Research Center. 15. Poster abstract.**
- Wong, Betty L.; Baggett, Kelly L.; Burfeind, Amy S.; Rye, Authur H. 2001. Carbohydrate profiles in woody tissues of sugar maples with crown dieback symptoms during the leafless period. In: Labrecque, Michel, ed. 2000 the tree: proceedings of the 4th international symposium on trees; 2000 August 20-25; Montreal, PQ. Montreal, PQ: Isabelle Quentin Press: 314-319.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4103

Attainment

Our data has provided unique evidence that acid rain exposure predisposes red spruce to freezing injury by leaching away calcium specifically associated with foliar cell membranes (3 manuscripts). Studies this year have verified that soil calcium depletion can also lead to membrane-associated calcium (mCa) deficiencies that predispose red spruce to freezing injury and decline. We are now evaluating if the lessons learned from red spruce are applicable to other tree species, including sugar maple. This summer we began to assess the mineral nutrition, physiology, and health of sugar maple trees growing in both natural stands and experimental sites manipulated to alter soil calcium availability. These studies, which include collaborative efforts with scientists in other NE projects, will focus on the association of soil, leaf, and membrane calcium levels with a variety of tree health parameters. In related work, we are studying the physiology of fall foliage color development in sugar maple. In addition to its aesthetic and economic benefits, fall coloration (particularly red color development) may be an important physiological indicator of tree stress that could be readily assessed at a range of scales (including remote sensing).

Separate work has shown that deterioration and loss of crown density of sugar maples reduces the production of photosynthate and storage of reserve carbohydrates. During the leafless period there is a highly significant negative correlation between starch content and soluble sugars in healthy trees with low levels of crown dieback. However, this correlation is not apparent in trees with greater crown dieback. In trees with elevated crown loss, high concentrations of soluble sugars (approximately 3 times the levels in healthy trees) occur during development of cold hardening. We are currently evaluating the effect of various stress factors (e.g., freezing temperature, drought, heavy seed production and altered soil chemistry) on the magnitude and pattern of carbohydrate storage needed within trees to safeguard health.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4103

Problem 2 Towards a better understanding of water-stress physiology: hydraulic sufficiency of stems to conduct water to leaves.

Publications

Research Tyree, Melvin T. 2001. Capillarity and sap ascent in a resurrection plant: does theory fit the facts? *New Phytologist*. 150(1): 9-11.

Tyree, Melvin T.; Nardini, Andrea; Salleo, Sebastiano. 2001. Hydraulic architecture of whole plants and single leaves. In: Labrecque, Michel, ed. 2000 the tree: proceedings of the 4th international symposium on trees; 2000 August 20-25; Montreal, PQ. Montreal, PQ: Isabelle Quentin Press: 215-221.

Wei, C.E.; Tyree, M.T.; Lintilhac, P.M. 2001. The essentials of direct xylem pressure measurement. *Plant, Cell and Environment*. 24: 549-555.

Extramural Engelbrecht, Bettina M.T.; Velez, Virginia; Tyree, Melvin T. 2000. Hydraulic conductance of co-occurring neotropical understory shrubs with different habitat preferences. *Annals of Forest Science*. 57: 201-208.

Attainment We have started a new extramural research program funded by the Andrew W. Mellon Foundation. The problem title is: "What role does water availability play in determining plant diversity of tropical forests?" Work in the first year involved field trials on seedling of 28 species of trees and shrubs. Control seedlings were grown with irrigation through the dry season and experimental seedlings were grown in rain-exclusion shelters to extend and intensify the natural dry season in the Panama Canal region. Growth rates and survivorship were monitored over a 26-week period. Large and significant differences in growth and survivorship of these species was found that were consistent with known distribution of the species in the natural rainfall gradients in the Panama Canal region. In July of 2001, we began greenhouse experiments on the same species subjected to drought cycles. The objective of this work is to document known mechanisms of desiccation avoidance and desiccation tolerance. The objective of this work is to see if differential expression of these mechanisms can help us understand the impact of rainfall patterns and global change on species diversity and survivorship. The other major accomplishment of this year is the completion of a book: "Xylem Structure and the Ascent of Sap" which summarizes 20 years of research on wood structure and hydraulic architecture of woody plants and the impact of this on growth and productivity of woody species. The book will be released by Springer-Verlag in 2002.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4104

Measurement, Analysis, and Modeling of Forest Ecosystems in a Changing Environment
Heath, Linda S, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Unit	Research Outputs	
				Extramural	Cooperative
1. Mechanistic analyses need to be advanced to reduce uncertainty about the consequences of ecosystem management alternatives and to assess the consequences of a changing environment.	188	2	3	3	2
2. Techniques to scale up biophysical processes from the levels of organs and organisms to ecosystems and landscapes need to be developed.	188	2	1	3	2
3. Knowledge of underlying processes must be integrated into operational tools to provide quantitative methods for adaptively managing our forest ecosystems.	188	2	5	2	0

NORTHEASTERN RESEARCH STATION

Research Unit NE-4104

- Problem 1** Mechanistic analyses need to be advanced to reduce uncertainty about the consequences of ecosystem management alternatives and to assess the consequences of a changing environment.
- Publications**
- Research** Valentine, H.T.; Gregoire, T.G. 2001. A switching model of bole taper. *Canadian Journal of Forest Research*. 31: 1400-1409.
- Valentine, Harry T. 2001. Influence of vertical foliage structure on the distribution of stem cross-sectional area increment in western hemlock and balsam fir [For. Sci. 46(1):86-94]. *Forest Science*. 47(1): 115-116.
- Valentine, Harry T.; Gove, Jeffrey H.; Gregoire, Timothy G. 2001. Monte Carlo approaches to sampling forested tracts with lines or points. *Canadian Journal of Forest Research*. 31: 1410-1424.
- Cooperative** Smith, J. E.; Heath, Linda S. 2000. Considerations for interpreting probabilistic estimates of uncertainty of forest carbon. Joyce, Linda A.; Birdsey, Richard, tech. eds. *The impact of climate change on America's forests: a technical document supporting the 2000 USDA Forest Service RPA assessment*. Gen. Tech. Rep. RMRS-GTR-59. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 102-111.
- Smith, James E.; Heath, Linda S. 2001. Identifying influences on model uncertainty: an application using a forest carbon budget model. *Environmental Management*. 27(2): 253-267.
- Extramural** Green, Edwin J.; MacFarlane, David W.; Valentine, Harry T. 2000. Assessing uncertainty in mechanistic models. In: Hansen, M.; Burk, T., eds. *Integrated tools for natural resources inventories in the 21st century, proceedings of the IUFRO conference; 1998 August 16-20; Boise, ID*. Gen. Tech. Rep. NC-212. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 501-506.
- MacFarlane, David W.; Green, Edwin J.; Valentine, Harry T. 2000. Incorporating uncertainty into the parameters of a forest process model. *Ecological Modelling*. 134: 27-40.
- Makela, Annikki; Valentine, Harry T. 2001. The ratio of NPP to GPP: evidence of change over the course of stand development. *Tree Physiology*. 21: 1015-1030.
- Attainment** A stand-level model of forest growth was developed under the classical paradigm of carbon balance, which divides respiration into maintenance and construction components, and a new paradigm, which derives respiration from several processes including construction, nitrate uptake and reduction, ion uptake, phloem loading, and maintenance. The resultant stand-level model helps scientists understand how age- and size-related changes in respiration affect the productivity and structural development of forests. This understanding is needed to solve the larger problem of predicting how global change will affect forests. Work continued on methods to estimate the uncertainty in forecasts from process-based models. A canopy model, based on optimality principles, was also developed to translate information obtained from satellites into estimates net ecosystem productivity.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4104

Problem 2 Techniques to scale up biophysical processes from the levels of organs and organisms to ecosystems and landscapes need to be developed.

Publications

Research Heath, Linda S. 2000. Assessing carbon sequestration on public timberland in the conterminous United States. In: Vasievich, J. Michael; Fried, Jeremy S.; Leefer, Larry A., eds. Seventh symposium on systems analysis in forest resources; 1997 May 28-31; Traverse City, MI. Gen. Tech. Rep. NC-205. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 257-260.

Cooperative Birdsey, Richard A.; Heath, Linda S. 2001. Forest inventory data, models, and assumptions for monitoring carbon flux. In: Soil carbon sequestration and the greenhouse effect. SSSA spec. publ. no. 57. Madison, WI: Soil Science Society of America: 125-135.

Heath, Linda S.; Chojnacky, David. 2001. Down dead wood statistics for Maine timberlands, 1995. Resour. Bull. NE-150. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 80.

Heath, Linda S.; Smith, James E. 2000. Soil carbon accounting and assumptions for forestry and forest-related land use change. In: Joyce, Linda A.; Birdsey, Richard, tech. eds. The impact of climate change on America's forests: a technical document support the 2000 USDA Forest Service RPA assessment. Gen. Tech. Rep. RMRS-GTR-59. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 89-101.

Extramural Falge, Eva; Baldocchi, Dennis; Olson, Richard; Anthoni, Peter; Aubinet, Marc; Bernhofer, Christian. 2001. Gap filling strategies for long term energy flux data sets. Agricultural and Forest Meteorology. 107(2001): 71-77.

Falge, Eva; Baldocchi, Dennis; Olson, Richard; Anthoni, Peter; Aubinet, Marc; Bernhofer, Christian. 2001. Gap filling strategies for defensible annual sums of net ecosystem exchange. Agricultural and Forest Meteorology. 107(2001): 43-69.

Pacala, S.W.; Hurtt, G.C.; Baker, D.; Peylin P.; Houghton, R.A.; Birdsey, Richard A. 2001. Consistent land- and atmosphere-based U.S. carbon sink estimates. Science. 292: 2316-2320.

Tu, Kevin. 2000. Modeling plant-soil-atmosphere carbon dioxide exchange using optimality. University of New Hampshire: 138p. Ph.D. dissertation.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4104

Attainment A long-term study of forest carbon, water, and energy exchange in a spruce-hemlock forest in Maine has completed its 5th year. This site is part of the AmeriFlux network investigating ecosystem carbon sequestration and is part of a collaborative project with the University of Maine and the Woods Hole Research Center. With 5 years of data, it is now clear that forest carbon sequestration can vary by over 50%, depending upon the seasonal weather. Tree characteristics were measured on 144 FIA-type plots around the 3 research towers and will be related to carbon flux measured by the towers. Two new projects have been initiated that use flux towers to measure the response of a whole ecosystem to an experimental treatment. The first is an examination of the impact of a shelterwood harvest on forest C exchange and storage. The second project is an investigation of the role of anthropogenic nitrogen fertilization on the forest carbon cycle. The first year fertilization of 50 acres of forest via helicopter has been completed.

We developed new live and dead biomass equations, forest floor carbon, and soil carbon equations for the U.S. carbon budget model. The volume-to-biomass equations feature a positive biomass at zero merchantable volumes. Overall, dead wood biomass averages about 10 percent of total live biomass in U.S. forests. We have the first regional scale analyses of down dead wood carbon in the U.S. based on plot-level data for New England states. Important variables to predict down dead wood include monthly maximum temperature and disturbance.

NORTHEASTERN RESEARCH STATION

Research Unit NE-4104

Problem 3 Knowledge of underlying processes must be integrated into operational tools to provide quantitative methods for adaptively managing our forest ecosystems.

Publications

- Research** Gove, Jeffrey H.; Ducey, Mark J.; Stahl, Goran; Ringvall, Anna. 2001. Point release samplings: a new way to assess downed coarse woody debris. *Journal of Forestry*. 99(4): 4-11.
- Gove, Jeffrey H.; Valentine, Harry T. 2000. A field test cut-off importance sampling for bole volume. In: Hansen, M.; Burk, T., eds. Integrated tools for natural resources inventories in the 21st century, proceedings of the IUFRO conference; 1998 August 16-20; Boise, ID. Gen. Tech. Rep. NC-212. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 372-276.
- Ringvall, Anna; Stahl, Goran; Teichmann, Vera; Gove, Jeffrey H.; Ducey, Mark J. 2001. Two-phase approaches to point and transect relascope sampling of downed logs. *Canadian Journal of Forest Research*. 31: 971-977.
- Solomon, Dale S.; Brann, Thomas B.; Caldwell, Lawrence E. 2000. Adaptation of FIBER for Forest Inventory and Analysis growth projections in the State of Maine. In: Hansen M.; Burk, T., eds. Integrated tools for natural resources in the 21st century, proceedings of the IUFRO conference; 1998 August 16-20; Boise, ID. Gen. Tech. Rep. NC-212. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 580-586.
- Solomon, Dale S.; Zhang, Lianjun. 2000. Maximum size-density relationships for mixed-hardwood forest stands in New England. In: Hansen M.; Burk, T., eds. Integrated tools for natural resources in the 21st century, proceedings of the IUFRO conference; 1998 August 16-20; Boise, ID. Gen. Tech. Rep. NC-212. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Central Research Station: 570-578.
- Extramural** Brann, Thomas, B.; Solomon, Dale S. 2001. FlexFIBER. Inventory processor and forest growth and management model: an introductory guide. In: Misc. Publ. 749. Orono, ME: University of Maine, Maine Agricultural and Forest Experiment Station: 80.
- Ducey, Mark J.; Gove, Jeffrey H.; Stahl, Goran; Ringvall, Anna. 2001. Clarification of the mirage method for boundary correction, with possible bias in plot and point sampling. *Forest Science*. 47(2): 242-245.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4104

Attainment Sampling at the forest boundary has long been a source of possible biases in forest inventory and numerous methods have been put forth over the years with varying degrees of success to address this problem. A new method, called the "walkthrough method" has been developed that will make correction for boundary overlap in the field a simple, intuitive matter and will produce unbiased estimates for trees lying near the forest edge. A new computer program has been developed for fitting diameter distributions to even- and uneven-aged stands. The program, Balance, was written for forest managers, researchers and students as a tool for understanding and modeling stand structure. Balance has a complete graphical user interface, supporting importing and exporting of data and graphics in various formats and runs on Microsoft Windows 95 and above platforms. Balance is also fully integrated with the FlexFIBER inventory and growth and yield system.

Cumulative mortality patterns following spruce budworm infestations were analyzed for spruce and fir forests of New England. Based on results, we developed guidelines for predicting protection strategies and scheduling harvests. The forest growth and management model FIBER has been expanded to include this mortality information.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4152

Understanding and Managing Forest Ecosystems of the Allegheny Plateau Region
Stout, Susan L, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Unit	Research Outputs	
				Extramural	Cooperative
1. Regeneration and forest renewal.	445	2	11	0	3
2. Stand dynamics and silviculture.	235	.8	1	0	0
3. Sugar maple decline.	344	1	1	0	2

NORTHEASTERN RESEARCH STATION
Research Unit NE-4152

Problem 1 Regeneration and forest renewal.

Publications

Research

Brose, P.H.; Van Lear, D.H.; Keyser, P.D. 2000. A shelterwood-burn technique for regenerating productive upland oak sites in the Piedmont region. In: Moser, W. Keith; Moser, Cynthia F., eds. Fire and forest ecology: innovative silviculture and vegetation management. Proceedings, 21st Tall Timbers fire ecology conference. Tallahassee, FL: Tall Timbers Research Station: 197. Poster abstract.

Brose, Patrick H. 1999. Oak advanced regeneration following seasonal prescribed fires in mixed hardwood shelterwood stands. In: Haywood, James D., ed. Proceedings of the tenth biennial southern silvicultural research conference; 1999 February 16-18; Shreveport, LA. Gen. Tech. Rep. SRS-30. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 15-20.

Brose, Patrick H.; Waldrop, Thomas A. 2000. Using prescribed fire to regenerate table mountain pine in the southern Appalachian Mountains. In: Moser, W. Keith; Moser, Cynthia F., eds. Fire and forest ecology: innovative silviculture and vegetation management: Proceedings, 21st Tall Timbers fire ecology conference; Tallahassee, FL. Tallahassee, FL: Tall Timbers Research Station: 27-32.

Lanham, Joseph D.; Keyser, Patrick D.; Brose, Patrick H.; Van Lear, David H. 2000. Oak regeneration using the shelterwood-burn technique: management options and implications for songbird conservation in the southeastern United States. In: Excellence in wildlife stewardship through science and education: The Wildlife Society 7th annual conference: program and abstracts; 2000 September 12-16; Nashville, TN. Bethesda MD: The Wildlife Society: 127. Abstract.

Ristau, Todd E.; Horsley, Stephen B.; McCormick, Larry H. 2001. Sampling to assess species diversity of herbaceous layer vegetation in Allegheny hardwood forests. *Journal of the Torrey Botanical Society*. 128(2): 150-164.

Stout, Susan L. 2001. A conflict between forest renewal and white-tailed deer: a silviculturist's perspective on values. In: Gibbon, Donald L., ed. Proceedings of the tenth biennial southern silvicultural research conference: conference on the impact of deer on the biodiversity and economy of the State of Pennsylvania; 1999 September 24-25; Harrisburg, PA. Harrisburg, PA: Wild Resource Conservation Fund: 27-32.

Stout, Susan; Finley, Jim. 2001. Advance regeneration-How much is enough? The Sustainable Forestry Initiative of Pennsylvania. Spring 2001: 8-10.

Stout, Susan; Finley, Jim. 2001. The role of research in the sustainable forestry initiative. The Sustainable Forestry Initiative of Pennsylvania. Winter: 8-10.

Stout, Susan; Finley, Jim. 2001. What are interfering plants, and when are they a problem? The Sustainable Forestry Initiative of Pennsylvania. Summer 2001: 8-10.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4152

- Research** Van Lear, D.H.; Brose, P.H.; Keyser, P.D. 2000. Using prescribed fire to regenerate oak. In: Yaussy, Daniel, R. comp. Proceedings, workshop on fire, people, and the central hardwoods landscape; 2000 March 12-14; Richmond, KY. Gen. Tech. Rep. NE-274. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 97-102.
- Waldrop, Thomas. A.; Welch, Nicole Turrill; Brose, Patrick H.; Elliott, Katherine J.; Mohr, Helen H.; Gray, Ellen A. 2000. Current research on restoring ridgetop pine communities with stand replacement fire. In: Yaussy, Daniel, R., comp. Proceedings, workshop on fire, people, and the central hardwoods landscape; 2000 March 12-14; Richmond, KY. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 103-109.
- Cooperative** DeMarco, Lois; Stout, Susan L. 2001. Use of monitoring and adaptive management to promote regeneration on the Allegheny National Forest. In: Proceedings, national silvicultural workshop; 1999 October 5-7; Kalispell, MT. RMRS-P-19. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 84-88.
- Wade, Dale D.; Brose, Patrick H.; Grace, James B.; Hoch, Greg A.; Patterson, William A., III. Chapter 4: fire in eastern ecosystems. In: Wildlife fire in ecosystems: effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol.2. Odgen, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 53-75.
- Waldrop, Thomas A.; Mohr, Helen M.; Brose, Patrick H.; Baker, Richard B. 1999. Seedbed requirements for regenerating table mountain pine with prescribed fire. In: Haywood, James D., ed. Proceedings of the tenth biennial southern silvicultural research conference; 1999 February 16-18; Shreveport, LA. Gen. Tech. Rep. SRS-30. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 369-373.
- Attainment** High densities of pin cherry (*Prunus pennsylvanica*) have significant impacts on stand development in Allegheny hardwood forests, from suppression of competing seedlings early in stand development to lower merchantable volumes of wood products much later in stand development. This knowledge was gained from analysis of several long-term studies, including one record spanning more than 60 years.
- The impact of white-tailed deer in forests varies with deer density and landscape conditions. Silviculture can be used to mitigate deer impact by increasing landscape forage production, although the benefit is short-lived when not accompanied by active control of deer numbers.
- Sampling to assess species diversity of herbaceous communities in managed Allegheny hardwood forest should include both plot-based and time-meander samples, and should occur at least twice during the growing season, once during the period when spring ephemerals are abundant.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4152

Attainment We are gaining increasingly sophisticated understanding of the impacts of prescribed fire on oak regeneration and other ecosystem processes in mixed oak forests. These impacts affect the abundance, size, and root: shoot ratio of oak seedlings and habitat for breeding birds. We have also studied these impacts in other eastern forests, including ridgetop pine communities such as those with table mountain pine.

We have analyzed and reported the impact of partial cutting in Allegheny hardwood forests on understory responses. The response varies with intensity of the partial cut and the time since cutting. Shade tolerant species respond to most partial cuttings with increased growth and abundance, and this response is sustained. Shade intolerant species respond primarily to heavy partial cuts, and the response diminishes with time. Fern cover at the time of cutting can reduce the response of tree species to the partial cutting.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4152

Problem 2 **Stand dynamics and silviculture.**

Publications

Research **Ristau, Todd E. 2001. Seventy-two years of change in the herbaceous vegetation layer of Heart's Content Scenic Area, Warren County, PA. In: Keeping all the parts: preserving, restoring, and sustaining complex ecosystems, Ecological Society of American 86th annual meeting; 2001 August 5-10; Madison, WI. Washington, DC: Ecological Society of America: 190. Abstract.**

Attainment **We have developed improved guidelines for optimizing wood production through partial cuttings in Allegheny hardwoods. These guidelines take into account differences in response by different species. Our current recommendations for target residual relative density, crop tree abundance and spacing, and residual stand structure.**

We have also begun to develop and report a systematic procedure for inventory of existing wildlife habitat conditions, and to link these conditions to those wildlife species (songbirds, small mammals, and amphibians) whose habitat needs might be met by current conditions.

We have developed a systematic procedure for estimating the standing carbon budget of small woodlot forests and for comparing the likely impacts of proposed forest management options on carbon budgets .

We have studied the conditions associated with a variety of silvicultural systems and stages of stand development, including multi-aged systems and old-growth forests. In particular, we have initiated regular remeasurements of a series of permanent plots established in the Hearts Content old-growth area in 1928. The results of the 2000 remeasurement suggests that the changes in the intervening seventy-two years are primarily those associated with selective browsing by white-tailed deer.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4152

Problem 3 **Sugar maple decline.**

Publications

- Research** Long, R.P.; Horsley, S.B.; Lilja, P.R.; Hall, T.J. 2000. Base cation nutrition and sugar maple health on the Allegheny Plateau. In: 2000 annual meeting of the American Society of Agronomy, Crop Science Society of America, Soil Science of America; 2000 November 5-9; Minneapolis, MN. Madison, WI: American Society of Agronomy: 338. Abstract.
- Long, Robert P.; Horsley, Stephen B.; Bailey, Scott W.; Hallett, Richard A. 2001. Sugar maple growth in relation to health, glaciation and foliar nutrition in northern Pennsylvania and southern New York. In: Keeping all the parts: preserving, restoring & sustaining complex ecosystems: Washington, DC: 86th annual meeting; 2001 August 5-10; Madison, WI. Washington DC: Ecological Society of America. 144. Abstract.
- Meding, S. Mercer; Morris, Lawrence A.; Hoover, Coeli M.; Nutter, Wade L.; Cabrera, Miguel L. 2001. Denitrification at a long-term forested land treatment system in the Piedmont of Georgia. *Journal of Environmental Quality*. 30(4): 1411-1420.
- Cooperative** Hallett, R.A.; Bailey, S.W.; Horsley, S.B.; Long, R.P. 2000. Cation nutrition: impacts on sugar maple in the northeastern United States. In: 2000 annual meeting of the American Society of Agronomy, Crop Science Society of America, Soil Science Society of America; 2000 November 5-9; Minneapolis, MN. Madison, WI: American Society of Agronomy: 348. Abstract.
- Hallett, R.A.; Bailey, S.W.; Horsley, S.B.; Long, R.P.; Hall, T.J. 2000. Sugar maple health in the northeastern United States: cation nutrition and defoliation stress. In: NADP proceedings 2000-01: ten years after the clean air act amendments: Adirondacks in the balance; 2000 October 17-20; Saratoga Springs, New York. [Place of publication unknown]: [Publisher unknown]: 35. Abstract.
- Horsley, Stephen B.; Long, Robert P.; Bailey, Scott W.; Hallett, Richard A.; Hall, Thomas J. 2000. Factors associated with the decline disease of sugar maple on the Allegheny Plateau. *Canadian Journal of Forest Research*. 30: 1365-1378.
- Horsley, Stephen B.; Long, Robert P.; Lilja, Paul R. 2001. Effects of fence, herbicide, and lime on regeneration of sugar maple in northern Pennsylvania. In: Keeping all the parts: Preserving, restoring, and sustaining complex ecosystems, the Ecological Society of American 86th annual meeting; 2001 August 5-10; Madison, WI. [Washington, DC]: [The Ecological Society of America]: 116. Abstract.
- Attainment** We hosted an international symposium on the ecology and health of sugar maple, and published the proceedings from the symposium. The symposium brought together scientists who had worked on sugar maple decline episodes in the Lake States, eastern Canada, New England, and Pennsylvania, and showed that most declines involved the interactions of nutrition with stresses such as defoliation, drought, or soil freezing.

NORTHEASTERN RESEARCH STATION
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Attainment The main accomplishments during the life of this problem are associated with an interdisciplinary, northeast-wide assessment of the interactions among site, stand, and disturbance characteristics, and their impact on sugar maple decline. In 2001, we showed that sugar maple decline on the Pennsylvania and southern New York sites of this study was most likely to develop on unglaciated sites at ridge top, shoulder, and upper backslope topographic positions. Declining stands had less than ~700 mg/kg Mg and two or more moderate to severe defoliations within the past 10 years. The decline disease of sugar maple seems to result from an interaction between Mg nutrition and stress caused by defoliation.

We also reported interim results of an ongoing long-term study of the impacts of forest liming on health and vigor of sugar maple. Addition of 10 tons/acre of dolomitic limestone increased survival, growth, and flower and seed crop production in sugar maple but not black cherry or American beech trees in study stands.

Earlier studies gave some insight into the sugar maple decline's scale and site characteristics associated with it in the Pennsylvania/New York region. We showed that on the Allegheny National Forest, decline was significantly correlated with elevation, soil moisture, and soil parent material. The decline could be detected in the 1989 Forest Inventory and Analysis Data collected by the United States Forest Service. Up to 400,000 acres in northern Pennsylvania were affected during the 1990s.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4153

**Quantitative Methods for Modeling and Monitoring Response of NE Forest Ecosystems to
Management and Environmental Stresses**
Yaussy, Daniel A, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Outputs		
			Research Unit	Extramural	Cooperative
1. Managers need improved methods for predicting natural communities and their response to management and disturbance.	393	1.6	1	0	0
2. Ecosystem management practices must be developed to meet demand for sustainability while providing timber products.	287	10	3	13	0
3. Integrated methods of monitoring forest ecosystems are needed sustainability and scientific understanding.	187	.5	2	0	0

NORTHEASTERN RESEARCH STATION
Research Unit NE-4153

Problem 1 **Managers need improved methods for predicting natural communities and their response to management and disturbance.**

Publications

Research **Prasad, Anantha M.; Iverson, Louis R. 2000. Predictive vegetation mapping using a custom built model-chooser: comparison of regression tree analysis and multivariate adaptive regression splines. In: 4th international conference on integrating GIS environmental modeling (GIS/EM4): problems, prospects and research needs; 2000 September 2-8; Banff, AB. Boulder, CO: University of Colorado: Online publication. Available at: <http://www.colorado.edu/research/cires/banff/upload/159/index.html>**

Attainment **Classical survival analysis has been applied to 40 years of individual tree measurements from more than 20,000 trees in Ohio and Kentucky. A model was developed using basal area growth, relative competitive status, and stand age to predict the survival probabilities of 13 central hardwoods species for 1 to 35 years into the future. The resulting model shows that, for the same size tree growing in the same conditions, a black oak tree is 3.2 times more likely to die than a chestnut oak tree.**

Multivariate adaptive regression splines, a new statistical software, was evaluated and compared to standard Regression Tree Analysis for its relative value in producing predictive vegetative maps of tree species. The new method looked very promising; but further testing revealed erratic model behavior outside the limits of the development data sets.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4153

Problem 2 **Ecosystem management practices must be developed to meet demand for sustainability while providing timber products.**

Publications

- Research** **Dickinson, Matthew B.; Johnson, Edward A. 2001. Tree death in surface fires: modeling the effects of elevated temperatures on the vascular cambium. In: Abstracts of the Ecological Society of America 86th annual meeting; 2001 August 5-10; Madison, WI Washington DC: Ecological Society of America: 80. Presentation abstract.**
- Iverson, Louis R.; Prasad, Anantha. 2001. Potential changes in tree species richness and forest community types following climate change. Ecosystems. 4: 186-199.**
- Sutherland, Elaine Kennedy; Hutchinson, Todd F. 2000. The restoration of oak-hickory forests in the central hardwoods: results of a landscape-scale prescribed burning experiment in Ohio. In: Excellence in wildlife stewardship through science and education: The wildlife Society 7th annual conference: program and abstracts; 2000-September 12-16; Nashville, TN. Bethesda, MD: The Wildlife Society: 195. Abstract.**
- Extramural** **Boerner, R.E.J.; Brinkman, J.A. 2001. Does repeated prescribed fire in oak-hickory forests result in changes in microbial community properties, or, is resistance futile? In: The Soil Ecology Society conference proceedings: 2001 a soil odyssey; 2001 May 20-23; Pine Martin, GA. Washington, DC: Ecological Society of America.**
- Boerner, Ralph E. 2001. Is prescribed fire effective in restoring eastern forest soils under heavy atmospheric N loading? In: Abstracts of the Ecological Society of America 86th annual meeting; 2001 August 5-10; Madison, WI. Washington, DC: Ecological Society of America: 7. Abstract.**
- Dennis, Teresa; Miles, Donald B. 2001. Effects of forest management practices on avian community structure and productivity. In: Abstracts of the Ecological Society of America 86th annual meeting; 2001 August 5-10; Madison, WI. (Washington, DC: Ecological Society of America: 271. Poster abstract.**
- Dress, W.J.; Frey, D.S.; Boerner, R.E.J. 2001. Spatial variation of microarthropods and soil fungi in a hardwood forest. In: The Soil Ecology Society conference proceedings: 2001 a soil odyssey; 2001 May 20-23; Pine Martin, GA. [Place of publication unknown]: [Publisher name unknown]: 138. Abstract.**
- Dress, W.J.; Frey, S.D.; Boerner, R.E.J. 2001. Spatial variation of microarthropods and soil fungi in a hardwood forest. In: The Soil Ecology Society conference proceedings: 2001 a soil odyssey; 2001 May 20-23; Pine Martin, GA. [Place of publication]: [Publisher name unknown]: 8. Poster abstract.**
- Dress, William J. 2001. Patterns of belowground productivity in oak-hickory forests in southern Ohio in relation to prescribed fire and landscape position. Columbus, OH: Ohio State University: 102p. Ph.D. dissertation.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4153

Extramural

Dress, William J.; Boerner, Ralph E.J. 2001. Root dynamics of southern Ohio oak-hickory forests: influences of prescribed fire and landscape position. *Canadian Journal of Forest Research*. 31: 644-653.

Dress, William J.; Frey, Serita D.; Boerner, Ralph E. 2001. Spatial variation in microarthropods and soil fungi in a hardwood forest. In: *Abstracts of the Ecological Society of America 86th annual meeting; 2001 August 5-10; Madison, WI. Washington, DC: Ecological Society of America: 273. Poster abstract.*

Knorr, M.A.; Brinkman, J.A.; Dress, W.J.; Thiet, R.K.; Strachan, R.; Swinehard E. [et al.]. 2001. Analysis of soil enzyme activities as an indicator of microbial community activity at three spatial scales in an Ohio deciduous forest landscape. In: *The Soil Ecology Society conference proceedings: 2001 a soil odyssey; 2001 May 20-23; Pine Martin, GA. [Place of publication unknown]: [Publisher name unknown]: 45. Poster abstract.*

Knorr, Melissa A.; Brinkman, Jennifer A.; Dress, William J.; Thiet, Rachael K.; Strachan, Ryan; Swinehart, Beth [et al.] 2001. Analysis of soil microbial activity at three spatial scales in an Ohio deciduous forest landscape. In: *Abstracts of the Ecological Society of America 86th annual meeting; 2001 August 5-10; Madison, WI. Washington, DC: Ecological Society of America: 304. Poster abstract.*

Riccardi, Cynthia L.; McCarthy, Brian C. 2001. Fuel loads in twelve southeastern Ohio mixed-oak stands. In: *Keeping all the parts: preserving, restoring, and sustaining complex ecosystems, Abstracts of the Ecological Society of America 86th annual meeting; 2001 August 5-10; Madison, WI. Washington, DC: Ecological Society of America: 188. Presentation abstract.*

Stanton, Robert Christopher. 2000. Ground beetle abundance and diversity patterns within mixed-oak forests subjected to prescribed burning in southern Ohio. Columbus, OH: Ohio State University: 151p. Ph.D. dissertation. 151.

Attainment

Three hundred acres were thinned and 300 were burned under prescription in southern Ohio as part of the treatments of the National Fire and Fire Surrogate (FFS) study. This completes the data collection for the Economics and Utilization and the Fuels and Fire Behavior portions of the study. The Vegetation, Soils, Pathology, and Wildlife disciplines are continuing to collect post-treatment data. Additional studies, which were outside the scope of the FFS, were initiated on the site with National Fire Plan funds, including mycorrhizal, deer exclosures, soil moisture dynamics, bat and flying squirrel surveys, and photographic fuel descriptions.

In order to determine urban forest characteristics related to socioeconomic factors, more than 200 trees in the city of Delaware, OH, were evaluated and positioned with GPS. Air photos were scanned, registered, and overlaid on the city's infrastructure. Methods developed should help urban managers better understand their cities' tree resources.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4153

Problem 3 **Integrated methods of monitoring forest ecosystems are needed for sustainability and scientific understanding.**

Publications

Research **Brown, Sandra; Iverson, Louis R.; Prasad, Anantha. 2001. Geographical distribution of biomass carbon in tropical southeast Asian forests: a database. ORNL/CDIAC-119; NDP-068. Oak Ridge, TN: U.S. Department of Energy, Oak Ridge National Laboratory, Carbon Dioxide Information Analysis Center: 75.**

Iverson, Louis R.; Cook, Elizabeth A. 2001. Urban forest cover of the Chicago region and its relation to household density and income. Urban Ecosystems. 4: 105-124.

Attainment **A project documenting the complete vascular flora of the Vinton Furnace Experimental Forest (VFEF) was begun. The objective of the project is to determine changes to the flora since 1956, when the last complete inventory was last done.**

Preliminary results of the fire history and maple recruitment study on the Ohio Hills site of the Fire and Fire Surrogate study, indicate that most maples began invading the oak forests when fires became less frequent (mid-1920s). The majority of the oak trees in these stands originated at the turn of the century.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4155

Ecology and Management of Northern Forest Ecosystems
Brissette, John C, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Unit	Research Outputs	
				Extramural	Cooperative
1. Understanding both ecologic and economic impacts of forest ecosystem manipulation.	563	4.1	9	1	0
2. Understanding relationships between composition and structure of forests and the needs of wildlife.	375	1.4	1	2	0
3. Understanding how natural and anthropogenic disturbances affect monitoring forest ecosystems are needed sustainability and scientific understanding.	361	2.5	3	3	3

NORTHEASTERN RESEARCH STATION
Research Unit NE-4155

Problem 1 **Understanding both ecologic and economic impacts of forest ecosystem manipulation.**

Publications

- Research** **Brissette, John C.; Sendak, Paul E.; Frank, Robert M. 2001. Long-term experiment at the Penobscot Experimental Forest: some 40-year results. In: Wagner, Robert G., comp. New England Society of American Foresters 81st annual winter meeting; 2001 March 14-16; South Portland, ME. [Place of publication unknown]: [Publisher unknown]: 37. Poster abstract.**
- Kenefic, Laura S. 2000. Leaf area, stemwood volume growth, and stand structure in a mixed-species, multi-aged northern conifer forest. Orono, ME: University of Maine: Ph.D. dissertation.**
- Kenefic, Laura S.; Brissette, John C. 2001. Uneven-aged silviculture in northern conifers: a 45-year study. In: Wagner, Robert G., comp. New England Society of American Foresters 81st annual winter meeting; 2001 March 14-16; South Portland, ME. [Place of publication unknown]: [Publisher unknown]: 40. Poster.**
- Kenefic, Laura S.; Seymour, Robert S. 2001. Leaf area-stemwood volume growth relationships for eastern hemlock, balsam fir, and red spruce in multi-aged stands. In: Wagner, Robert G., comp. New England Society of American Foresters 81st annual winter meeting; 2001 March 14-16; South Portland, ME [Place of publication unknown]: [Publisher unknown]: 16. Poster abstract.**
- Kenefic, Laura; Nyland, Ralph; Sokol, Kerry; Brissette, John; Sendak, Paul. 2001. Diameter-limit cutting in northeastern forests. In: Third North American forest ecology workshop; 2001 June 24-27; Duluth, WI [Place of publication unknown]: [Publisher unknown]: 117. Poster abstract.**
- Kenefic, Laura; Seymour, Robert S. 2001. Tree- and stand-level area-stemwood volume growth relationships in a mixed-species, multi-aged northern conifer forest. In: Third North American forest ecology workshop; 2001 June 24-27; Duluth, WI. [Place of publication unknown]: [Publisher unknown]: 64. Abstract.**
- Lamson, Neil I.; Leak, William B. 2000. Guidelines for applying group selection harvesting. NA-TP-02-00. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry: 8.**
- Long, Robert P.; Horsley, Stephen B.; Bailey, Scott W.; Hallett, Richard A. 2001. Sugar maple growth in relation to health, glaciation and foliar nutrition in northern Pennsylvania and southern New York. In: Keeping all the parts: preserving, restoring & sustaining complex ecosystems: Washington, DC: 86th annual meeting; Ecological Society of America: Ecological Society of America; 2001 August 5-10; Madison, WI. 144. Abstract.**
- Sokol, Kerry A.; Kenefic, Laura S.; Greenwood, Michael S. 2001. Effects of diameter-limit cutting on red spruce in mixed-species northern conifer stands. In: Wagner, Robert G., comp. New England Society of American Foresters 81st annual winter meeting; 2001 March 14-16; South Portland, ME. [Place of publication unknown]: [Publisher unknown]: 12. Poster abstract.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4155

- Research** **Wagner, Robert G.; Seymour, Robert S.; Day, Michael E.; White, Alan S.; Greenwood, Mike S.; Hunter, Malcolm L. 2001. Ecological effects of expanding-gap silvicultural systems in the Acadian forest. In: Wagner, Robert G., comp. New England Society of American Foresters 81st annual meeting; 2001 March 14-16; South Portland, ME. [Place of publication unknown]: [Publisher unknown]: 9. Poster abstract.**
- Cooperative** **Dennis, Donald F.; Sendak, Paul E.; McEvoy, Thom J. 2000. Analysis of timber prices in New England. In: Vasievich, J. Michael; Fried, Jeremy S.; Leefer, Larry A., eds. Seventh symposium on systems analysis in forest resources; 1997 May 28-31; Traverse City, MI. Gen. Tech. Rep. NC-205. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 450-452.**
- LeDoux, Chris B.; Sendak, Paul E.; McWilliams, William H.; Huyler, Neil; Malecek, Thomas; Muzzey, Worthen; Jones, Toni. 2001. Timber supply and demand assessment of the Green and White Mountain National Forests' market area. In: Gen. Tech. Rep. NE-280. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 19.**
- Extramural** **Wagner, Robert G. 2000. Competition and critical-period thresholds for vegetation management decisions in young conifer stands. The Forestry Chronicle. 76(6)November/December: 961-968.**
- Attainment** **A cooperative education student completed requirements for a Ph.D. in silviculture and was converted to a scientist working primarily in this problem area. Harvesting was completed in a size of opening study on the Bartlett Experimental Forest (BEF). Post-harvest measurements were started to determine basal area and volume removed and to evaluate stand structural changes resulting from the harvest. Subsequent re-measurements will record regeneration and stand dynamics. NEPA process was completed and trees marked for harvest in a commercial thinning study on the BEF. At the Penobscot Experimental Forest (PEF), a precommercial thinning study was remeasured and regeneration and stand re-measurements were completed on 6 compartments in the long-term silviculture study. Two compartments were marked for harvest in accordance with the study plan. Revision of that plan was begun with a review by scientists and managers representing a range of cooperators and clients. The revised study plan will build on over 40 years of results. In cooperation with the University of Maine (UME), a state-wide commercial thinning study in northern conifers was established with a replication at the PEF.**
- New research was initiated with Joint Fire Science Team funding to study options for controlling woody invasive plants in the northeast and mid-Atlantic states. A term research ecologist and support staff were hired to conduct the study. UME cooperators initiated new research on the PEF to examine forest management effects on biodiversity.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4155

Attainment **Project scientists in this problem area presented 7 guest lectures at universities and made 6 oral and 8 poster presentations at scientific or professional meetings; participated in 5 workshops for managers; hosted 6 field tours of experimental forests; and served on several committees for state agencies and universities. Project personnel provided technical expertise on a Sustainable Forestry Initiative audit of International Paper operations in the northeastern United States. One scientist moderated a session at the National Silviculture Workshop. Another scientist worked with Russian and American scientists and managers on a sustainable forestry project in central Siberia.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4155

Problem 2 **Understanding relationships between composition and structure of forests and the needs of wildlife.**

Publications

Research **Yamasaki, Mariko. 2000. Forestry effects on vertebrate species habitats in the riparian zone. In: Forestry and the Riparian Zone, conference proceedings of the forest ecosystem exchange; 2000 October 26; Orono, ME. [Publisher name unknown]: [Place of publication unknown]: 31-35.**

Cooperative **DeGraaf, Richard M.; Yamasaki, Mariko. 2001. New England wildlife: habitat, natural history, and distribution. Hanover, NH: University Press of New England: 482.**

Extramural **Sasse, D. Blake; Pekins, Peter J. 2000. Ectoparasites observed on northern long-eared bats, *Myotis septentrionalis*. Bat Research News. 41(3): 69.**

Su, J.C.; Woods, S.A. 2001. Importance of sampling along a vertical gradient to compare the insect fauna in managed forests. Environmental Entomology. 30(2): 400-408.

Attainment **Progress continued in describing associations between forest-dwelling wildlife and forest structure through: (1) cooperative work with the University of New Hampshire (UNH) on stream salamander and fish competition in various watersheds in the White Mountains of New Hampshire; (2) breeding bird and small mammal sampling on the size-of-opening study (see Problem 1) on the Bartlett Experimental Forest (BEF); (3) effects of ice storm disturbance and forest management practices on terrestrial salamander habitat and occurrence in the size-of-opening study (with USDA National Research Cooperative Grant and UNH Cooperative Extension ice storm funding from UNH cooperator); and (4) forest bat sampling using ultrasonic detection and mist netting on the BEF size-of-opening study in response to the need of National Forest personnel in New England for information on bat use of forest habitats.**

Project personnel in this problem area made 2 oral presentations at scientific or professional meetings; participated in 3 workshops for managers; hosted 4 field tours of experimental sites; and served on several committees for state agencies and universities. Project personnel provided technical expertise on a Sustainable Forestry Initiative audit of International Paper operations in the northeastern United States. Project personnel served on technical advisory groups for bats, mammals, birds, and herbs for New Hampshire Fish and Game Department and the Public Land Management Technical Committee for the NH Ecological Reserve System Project. Project personnel provided technical expertise on a Sustainable Forestry Initiative audit of International Paper operations in the northeastern United States.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4155

Problem 3 **Understanding how natural and anthropogenic disturbances affect ecological processes.**

Publications

Research **Pontius, Jennifer. 2001. Mechanisms of hemlock woolly adelgid infestation and host response in northeastern forests. In: Gerry Lanier Graduate Student Symposium, Northeastern Forest Pest Council/New England Society of American Foresters Meeting; 2001 March; Portland, ME. [Place of publication unknown]: [Publisher name unknown]. Abstract.**

Smith, M.L.; Martin, M.E.; Ollinger, S.V. 2000. Hyperspectral remote sensing of forest ecosystem productivity and nutrient cycling. In: American Society of Photogrammetry and Remote Sensing 2000 proceedings; 2000 May 22-26; Washington, DC. Bethesda, MD: American Society for Photogrammetry and Remote Sensing. Abstract.

Smith, Marie-Louise; Martin, Mary E. 2001. A plot-based method for rapid estimation of forest canopy chemistry. Canadian Journal of Forest Research. 31(3): 549-555.

Cooperative **Hallett, R.A.; Bailey, S.W.; Horsley, S.B.; Long, R.P. 2000. Cation nutrition: impacts on sugar maple in the northeastern United States. In: 2000 annual meeting of the American Society of Agronomy, Crop Science Society of America, Soil Science Society of America; 2000 November 5-9; Minneapolis, MN. Madison, WI: American Society of Agronomy: 348. Abstract.**

Hallett, R.A.; Bailey, S.W.; Horsley, S.B.; Long, R.P.; Hall, T.J. 2000. Sugar maple health in the northeastern United States: cation nutrition and defoliation stress. In: NADP proceedings 2000-01: ten years after the clean air act amendments: Adirondacks in the balance; 2000 October 17-20; Saratoga Springs, New York [Place of publication unknown]: [Publisher unknown]: 35. Abstract.

Horsley, Stephen B.; Long, Robert P.; Bailey, Scott W.; Hallett, Richard A.; Hall, Thomas J. 2000. Factors associated with the decline disease of sugar maple on the Allegheny Plateau. Canadian Journal of Forest Research. 30: 1365-1378.

Smith, Marie-Louis; Martin, Mary E.; Ollinger, S.V.; Hallett, Richard A.; Alber, John D.; Bailey, Scott. 2000. The MAPBGC Project: hyperspectral remote sensing, mapping, and analysis of forest productivity and biogeochemical cycles in the White Mountains, NH. In: Greer, Jerry Dean, ed. Remote sensing and geospatial technologies for the new millennium, proceedings of the eighth Forest Service remote sensing applications conference; 2000 April 10-14; Albuquerque, NM. Bethesda, MD: American Society for Photogrammetry and Remote Sensing.

Extramural **Day, Michael E. 2000. Factors influencing net primary production in red spruce. Orono, ME: University of Maine: 172p. Ph.D. dissertation.**

Eckhoff, Janet Dawn. 2000. Efficacy of forest health monitoring indicators to evince impacts on a chemically manipulated watershed. Orono, ME: University of Maine. 318p. Ph.D. dissertation.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4155

- Extramural** Thompson, Ralph L.; Jones, Ronald L.; Abbott, J. Richard; Denton, W. Neal. 2000. Botanical survey of Rock Creek Research Natural Area, Kentucky. In: Gen. Tech. Rep. NE-272. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 23.
- Attainment** A Scientist Recruitment Initiative (SRI) employee began her graduate program in quantitative ecology at the University of New Hampshire (UNH). One aspect of research under this problem area focuses on studies to test the ability of emerging airborne and satellite-based imaging spectrometers to detect complex ecosystem processes such as forest productivity and biogeochemical cycling in diverse forest systems, while simultaneously examining important environmental controls on these processes. Initial results from a broad-scale study in the White Mountain National Forest (MAPBGC) that demonstrated the potential for remote estimation of forest growth and C and N cycling via airborne image spectrometry are in press. Based on results from that study, project scientists were chosen by NASA through a competitive proposal process to assist in evaluation of the capabilities of EO-1 Hyperion instrument, the first space-based imaging spectrometer, for determination of forest ecosystem biogeochemistry, productivity, and composition. This study, initiated in FY2001, focuses on forest systems in the northeastern U.S. (White Mountains, NH and Catskill Mountains, NY) and in the southern hemisphere (Bago-Maragale State Forest, New South Wales (NSW), Australia). Analyses were begun on data from the floristic inventory of the Massabesic Experimental Forest that was completed last fiscal year. Ten-year re-measurements of long-term growth plots at the Bartlett Experimental Forest were started.
- Additional funding awarded project scientists in this problem area included a New England Research Cooperative grant to summarize the state of knowledge about foliar chemistry in the northeast and, in cooperation with researchers from the UNH and RWU-NE-4104, a NASA Carbon Cycle Science grant to examine the potential for scaling forest carbon flux measurements via hyperspectral remote sensing from site to landscapes along a gradient from boreal ecotone forest (northern Maine) to tropical forest (northern Brazil).
- Project scientists in this problem area gave 2 guest lectures at UNH, made 8 oral presentations at scientific or professional meetings, participated in 3 workshops, and serve on the graduate committee of our SRI employee. One scientist was part of a team working in NSW, Australia, to evaluate the EO-1 satellite.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4251

Wildlife and Fish Habitat Relationships and Recreation Opportunities in New England Forests
DeGraaf, Richard M, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Unit	Research Outputs	
				Extramural	Cooperative
1. Vegetation structure and forest wildlife distribution.	525	2	7	1	4
2. Atlantic salmon habitat research.	299	1	1	1	0
3. Acorn production and ecosystem dynamics.	80	.5	0	0	0
4. Ecology of seasonal forest ponds.	140	1	2	0	1
5. Wildlife-related recreation and natural resources planning.	0	0	0	1	0

NORTHEASTERN RESEARCH STATION
Research Unit NE-4251

Problem 1 **Vegetation structure and forest wildlife distribution.**

Publications

Research **Brooks, Robert T. 2001. Effects of the removal of overstory hemlock from hemlock-dominated forests on eastern redback salamanders. *Forest Ecology and Management*. 149: 197-204.**

DeGraaf, Richard M.; Maier, Thomas J. 2001. Obtaining and storing house sparrow eggs in quantity for nest-predation experiments. *Journal of Field Ornithology*. 72(1): 124-130.

King, David I.; DeGraaf, Richard M. 1999. Silvicultural options for managing birds in northern hardwoods forests in extensively forested landscapes. *Bird Observer*. 27(5): 232-237.

King, David I.; DeGraaf, Richard M.; Champlin, Paul J.; Champlin, Tracey B. 2001. A new method for wireless video monitoring of bird nests. *Wildlife Society Bulletin*. 29(1): 349-353.

King, David I.; DeGraaf, Richard M.; Griffin, Curtice R. 2001. Productivity of early successional shrubland birds in clearcuts and groupcuts in an eastern deciduous forest. *Journal of Wildlife Management*. 65(2): 345-350.

Maier, Thomas J.; DeGraaf, Richard M. 2000. Rhodamine-injected eggs to photographically identify small nest-predators. *Journal of Field Ornithology*. 71(4): 694-701.

Maier, Thomas J.; DeGraaf, Richard M. 2001. Differences in depredation by small predators limit the use of plasticine and zebra finch eggs in artificial-nest studies. *The Condor*. 103(1): 180-183.

Cooperative **DeGraaf, Richard M.; Yamasaki, Mariko. 2001. *New England wildlife: habitat, natural history, and distribution*. Hanover, NH: University Press of New England: 482.**

Thompson, Frank R. III; DeGraaf, Richard M. 2001. Conservation approaches for woody, early successional communities in the eastern United States. *Wildlife Society Bulletin*. 29(2): 483-494.

Thompson, Frank R. III; DeGraaf, Richard M.; Trani, Margaret K. 2001. Conservation of woody, early successional habitats and wildlife in the eastern United States. *Wildlife Society Bulletin* 2001. 29(2): 407-494.

Trani, Margaret K.; Brooks, Robert T.; Schmidt, Thomas L.; Rudis, Victor A.; Gabbard, Christine M. 2001. Patterns and trends of early successional forests in the eastern United States. *Wildlife Society Bulletin*. 29(2): 413-424.

Extramural **Byers, Bruce E.; King, David I. 2000. Singing by female chestnut-sided warblers. *Wilson Bulletin*. 112(4): 547-550.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4251

Attainment Recent evidence indicates that bird species which breed in early-successional habitats are undergoing more widespread population declines in the northeastern U.S. than are mature forest species. A comparison of the effects of group selection and clearcutting on nest survival rates of early successional shrubland birds showed no difference in daily nest survival rates for 16 species of birds combined, nor for the most abundant species, Chestnut-Sided Warbler. No differences in daily nest survival were identified between edges and interiors of either clearcuts for groupcuts. These results suggest that both silvicultural treatments provide similar habitat for shrubland bird species that inhabit both clearcuts and groupcuts. Also, a new wireless video system was developed to monitor birds' nests to access predation. The infra-red camera monitors nests day and night, and transmits images up to 200 m to a recording station. Up to four nests can be monitored by each video recorder, and no differences were found between monitored and unmonitored nests.

Artificial nests are commonly used to index predation on nests in various forest conditions, often in conjunction with still cameras to identify predators. Small mammals such as mice and voles have been implicated as major egg predators of Neotropical migratory birds in field studies using soft clay eggs or small Zebra finch eggs. We compared predation on these egg surrogates to that on real eggs of size similar to those of most Neotropical migrant passerines. Dissimilar pairs of clay, Zebra finch, and House Sparrow eggs were exposed to predation by captive white-footed mice. Clay eggs were marked more than either kind of real egg, and Zebra finch eggs were opened more than House Sparrow eggs. The use of either clay or Zebra finch eggs in artificial nest experiments may overestimate the role of small mammals as actual predators of passerine nests. Treatment of House Sparrow eggs with Rhodamine-B dye increases the photographic detection of predators in artificial nest experiments.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4251

Problem 2 **Atlantic salmon habitat research.**

Publications

Research Nislow, Keith H.; Folt, Carol L.; Parrish, Donna L. 2000. Spatially explicit bioenergetic analysis of habitat quality for age-0 Atlantic salmon. *Transactions of the American Fisheries Society*. 129: 1067-1081.

Extramural Kennedy, Brian P.; Blum, Joel D.; Folt, Carol L.; Nislow, Keith H. 2000. Using natural strontium isotopic signatures as fish markers: methodology and application. *Canadian Journal of Fisheries and Aquatic Sciences*. 57(11): 2280-2292.

Attainment Understanding the sources of variation in juvenile growth and survival is critical for salmonid restoration efforts. We used common environment experiments to evaluate the relative roles of heritable (among-family) vs. environmental (among-site) variation in the context of a major effort to restore the Atlantic salmon to the Connecticut River basin, USA. In these experiments, offspring of a random sample of six crosses were divided into eight lots. Seven of these lots were then stocked as unfed fry at seven different rearing sites throughout the basin, with one lot being raised in the hatchery. After 4 months, we sampled salmon in the field and at the hatchery, and tested for differences among sites and families. We found that growth and survival of age-0 Atlantic salmon varied widely across both sites and families, encompassing a range of variation representative of the entire basin. Across sites, age-0 survival was positively correlated with the availability of habitat for newly-stocked salmon. Across families, while there were no differences in hatchery survival rates, we found that in the field, the family that was largest at stocking had nearly twice the survival rates of the other five families.

However, a different family, which had low survival rates in the field, had the highest age-0 growth rates. At our single long-term study site, these families maintained their respective size and survival advantage even after their first winter. These results have important implications for salmon restoration. Higher survival in sites with a greater availability of favorable foraging locations, and higher survival of families that are larger at stocking, indicate the importance of the first few weeks after stocking/emergence as a determinant of age-0 cohort strength in juvenile salmon. Also, the presence of significant, heritable variation in traits that strongly affect growth and survival suggest a substantial capacity for restored stocks to adapt to new environmental situations. Overall, our results illustrate the utility of common-environment experiments in addressing important conservation and management issues.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4251

Problem 3 **Acorn production and ecosystem dynamics.**

Publications

Attainment **No progress to report this period.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4251

Problem 4 **Ecology of seasonal forest ponds.**

Publications

- Research** Brooks, Robert T.; Lust, Noel, eds. 2001. The science of managing forests to sustain water resources: partial proceedings of an international conference. *Forest Ecology and Management*. 143: 1.
- Brooks, Robert T.; Doyle, Katherine L. 2001. Shrew species richness and abundance in relation to vernal pond habitat in southern New England. *Northeastern Naturalist*. 8(2): 137-148.
- Cooperative** Brooks, Robert T. 2000. Annual and seasonal variation and the effects of hydroperiod on benthic macroinvertebrates of seasonal forest ("vernal") ponds in central Massachusetts, USA. *Wetlands*. 20(4): 707-715.
- Attainment** Seasonal ("vernal") forest pools are isolated, ephemeral lentic habitats in upland forest ecosystems. Vernal pools occur commonly throughout temperate forests. The pools are important habitat for many faunal species, dominated by invertebrates but critical to a small number of amphibian species. The incidental capture of many shrews during amphibian surveys, and the abundance of potential invertebrate prey suggested that the pools might be important habitat for shrews. A survey of small mammal populations in forest habitat adjacent to vernal pools and in comparable upland forest identified no significant differences in shrew community composition or in the relative abundance of any of the three shrew species. Vernal pools in northeastern forests are small and highly variable in persistence, apparently providing an unreliable resource for shrews.

The persistence or duration of the wet phase of vernal pools is termed the hydroperiod and is an influential factor in temporary waters, affecting many ecological functions. The richness and diversity of vernal pool benthic macroinvertebrates (BMI) was found to increase with hydroperiod; no relationship between BMI relative abundance and hydroperiod was identified. Differences in the relative abundance of individual taxa relative to hydroperiod were found, with Chironomidae and Oligochates more abundant in short hydroperiod pools and Crustacea more abundant in long hydroperiod pools. Vernal pools exist as aquatic islands in a "sea" of forest, and hydroperiod is analogous to island size. Longer hydroperiod (larger) pools generally have richer invertebrate community, just as larger marine islands typically have richer faunas. However, this relationship is confounded by the relationship between hydroperiod and the physical size (area, volume) of pools.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4251

Problem 5 **Wildlife-related recreation and natural resources planning.**

Publications

Extramural **Hrubes, Daniel; Azjen, Icek; Daigle, John. 2001. Predicting hunting intentions and behavior: an application of the theory of planned behavior. Leisure Sciences. 23: 165-178.**

Attainment **No progress to report at this time.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4352

Ecological Processes: A Basis for Managing Forests and Protecting Water Quality in New England
Eagar, Christopher, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Unit	Research Outputs	
				Extramural	Cooperative
1. How do the cumulative effects of disturbance and atmospheric deposition affect biogeochemistry of nutrient base cations, forest health, and ecosystem function in northern hardwood forests?	948	1.5	2	5	4
2. What is the range of mineral weathering contributions to nutrient capital in northeastern forests?	384	.8	0	0	0
3. What processes and conditions control the extent to which forest and aquatic ecosystems respond to nitrogen deposition?	632	1.1	2	0	1
4. What are dynamics of community structure, biomass accumulation, and nutrient uptake of northeastern forest ecosystems: how are they effected by disturbances?	113	.2	0	0	1
5. Synthesize knowledge and long-term data bases to develop guidelines for natural resource managers to protect stream quality, etc.	180	.3	2	0	2
M1. Hubbard Brook Experimental Forest will be maintained: for forest ecosystem research; as Biosphere Reserve.	350	.6	1	2	1

NORTHEASTERN RESEARCH STATION
Research Unit NE-4352

Problem 1 How do the cumulative effects of disturbance and atmospheric deposition affect biogeochemistry of nutrient base cations, forest health, and ecosystem function in northern hardwood forests?

Publications

Research Berger, Torsten W.; Eagar, Chris; Likens, Gene E.; Stinger, Gerhard. 2001. Effects of calcium and aluminum chloride additions on foliar and throughfall chemistry in sugar maples. *Forest Ecology and Management*. 149: 75-90.

Martin, C.W.; Driscoll, C.T.; Fahey, T.J. 2000. Changes in streamwater chemistry after 20 years from forested watersheds in New Hampshire. *Canadian Journal of Forest Research*. 30(8): 1206-1213.

Cooperative Hallett, R.A.; Bailey, S.W.; Horsley, S.B.; Long, R.P. 2000. Cation nutrition: impacts on sugar maple in the northeastern United States. In: 2000 annual meeting of the American Society of Agronomy, Crop Science Society of America, Soil Science Society of America; 2000 November 5-9; Minneapolis, MN. Madison, WI: American Society of Agronomy: 348. Abstract.

Hallett, R.A.; Bailey, S.W.; Horsley, S.B.; Long, R.P.; Hall, T.J. 2000. Sugar maple health in the northeastern United States: cation nutrition and defoliation stress. In: NADP proceedings 2000-01: ten years after the clean air act amendments: Adirondacks in the balance; 2000 October 17-20; Saratoga Springs, New York [Place of publication unknown]: [Publisher unknown]: 35. Abstract.

Horsley, Stephen B.; Long, Robert P.; Bailey, Scott W.; Hallett, Richard A.; Hall, Thomas J. 2000. Factors associated with the decline disease of sugar maple on the Allegheny Plateau. *Canadian Journal of Forest Research*. 30: 1365-1378.

Rustad, L.E.; Campbell, J.L.; Marion, G.M.; Norby, R.J.; Mitchell, M.J.; Hartley, A.E. 2001. A meta-analysis of the response of soil respiration, net nitrogen mineralization, and aboveground plant growth to experimental ecosystem warming. *Oecologia*. 126: 543-562.

Extramural Briggs, R.D.; Hornbeck, J.W.; Lemin, R.C., Jr.; McCormack, M.L., Jr. 2000. Long-term effects of forest management on nutrient cycling in spruce-fir forests. *Forest Ecology and Management*. 138: 285-299.

Driscoll, C.T.; Lawrence, G.B.; Bulger, A.J.; Butler, T.J.; Cronan, C.S.; Eagar, C.; Lambert, K.F.; Likens, G.E.; Stoddard, J.L.; Weathers, K.C. 2001. Acid rain revisited: advances in scientific understanding since the passage of the 1970 and 1990 Clean Air Act Amendments. Hanover, NH: Hubbard Brook Research Foundation. 20p.

Driscoll, Charles T.; Lawrence, Gregory B.; Bulger, Arthur J.; Butler, Thomas J.; Cronan, Christopher S.; Eagar, Christopher. 2001. Acidic deposition in the northeastern United States: sources, inputs, ecosystem effects, and management strategies. *BioScience*. 51(3): 180-198.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4352

- Extramural** Evans, Jennifer L.; Fernandez, Ivan J.; Rustad, Lindsey E.; Norton, Stephen A. 2001. Methods for evaluating carbon fractions in forest soils; a review. In: Tech. Bull. 178. Orono, ME: University of Maine, Maine Agricultural and Forest Experiment Station: 39.
- Shaver, Gaius R.; Canadell, Josep; Chapin, F.S. III; Gurevitch, Jessica; Harte, John; Henry, Greg; Ineson, Phil; Jonasson, Sven; Melillo, Jerry; Pitelka, Louis; Rustad, Lindsey. 2000. Global warming and terrestrial ecosystems: a conceptual framework for analysis. *BioScience*. 50(10): 871-882.
- Attainment** Long-term patterns of streamwater chemistry provide valuable evidence of the effects of environmental change on ecosystem biogeochemistry. Observations from old-growth forests may be particularly valuable, because patterns should not be influenced by forest succession. Water samples were collected biweekly from four streams in, and near, the old-growth forest watershed of the Bowl Research Natural Area in the White Mountains of New Hampshire in 1973 and 1974, and in 1994 through 1997. Average NO_3^- concentrations, which ranged from 40.8 to 46.1 $\mu\text{equiv}\cdot\text{L}^{-1}$ in 1973-1974, declined significantly to averages of 14.9-20.1 $\mu\text{equiv}\cdot\text{L}^{-1}$ during 1994-1997. Concentrations of the base cations, Ca^{2+} and Mg^{2+} , also declined in stream water between the two sampling periods. The northeastern United States, including the study area, has been subjected to elevated atmospheric deposition of sulfur and nitrogen for more than 40 years. This observation has led us to the concern that mature forest ecosystems may exhibit N saturation and depletion of Ca^{2+} from exchangeable soil pools. While the Bowl exhibits a pattern of elevated concentrations of NO_3^- throughout the year, suggestive of conditions of N saturation, concentrations have declined markedly over the last 20 years. Concentrations of Ca^{2+} have also declined, suggesting possible depletion from the exchangeable soil pool, but the acid neutralizing capacity of stream water has remained constant or increased, indicating resistance to additional acidification.
- Calcium availability for sugar maple stands at the Hubbard Brook Experimental Forest (New Hampshire, USA) was tested by experimental addition of CaCl_2 and AlCl_3 . Four years of data from 12 throughfall collection sites were used to evaluate effects on throughfall chemistry. Calcium additions increased Ca foliar contents significantly. Leaching rates for Ca, Mg, and K were not significantly different between the treatments (surprising Ca leaching tended to decrease with increasing foliar Ca content). We suggest that Ca supply to Ca deficient sugar maple trees protected the foliage from increased leaching of Ca (and other elements) due to improved integrity of cell membrane and cell wall formation from Ca. Increasing acidity of precipitation caused increased leaching of Ca, Mg, and K. About half of the cation leaching from these sugar maple canopies is attributable to a cation-exchange reaction driven almost entirely by H^+ in precipitation.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4352

Problem 2 **What is the range of mineral weathering contributions to nutrient capital in northeastern forests?**

Publications

Attainment **Watershed mass balance studies have shown that acid deposition and intensive forest harvesting can remove significant amounts of critical plant nutrients at some sensitive sites. Little is known about the location and extent of sensitive sites at the landscape level. We are developing a method to predict spatial patterns in sensitivity to nutrient depletion. The till source model predicts the lithologic source of soil parent material in glaciated terrain. This past year, the model was enhanced by development of a database of bedrock mineralogy and chemistry for all bedrock map units in northern New Hampshire and adjacent portions of Vermont and Maine. Computer code was written which allows the till source model to use this database to predict soil chemistry and mineralogy. The model is run within a geographic information system. Draft maps of soil chemistry for the White Mountain National Forest have been produced. Ongoing activities include soil chemical analyses from samples collected across the WMNF to calibrate the model. Finally, validation sampling is planned to confirm that predictions of sensitive and insensitive sites are valid. This will provide an invaluable tool to managers of the White Mountain National Forest to adjust management plans to better protect long-term soil quality and site productivity. Progress has been slow the last two years, as the lead scientist worked on another study (sugar maple decline).**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4352

Problem 3 **What processes and conditions control the extent to which forest and aquatic ecosystems respond to nitrogen deposition?**

Publications

Research **Campbell, John L.; Eagar, Christopher; McDowell, William H.; Hornbeck, James W. 2000. Analysis of nitrogen dynamics in the Lye Brook Wilderness Area, Vermont, USA. Water, Air, and Soil Pollution. 122: 63-75.**

Pardo, L.H.; Hemond, H.F.; Montoya, J.P.; Siccama, T.G. 2001. Long-term patterns in forest-floor nitrogen-15 natural abundance at Hubbard Brook, NH. Soil Science Society of America Journal. 65(July-August): 1279-1283

Cooperative **Long, Robert P.; Horsley, Stephen B.; Bailey, Scott W.; Hallett, Richard A. 2001. Sugar maple growth in relation to health, glaciation and foliar nutrition in northern Pennsylvania and southern New York. In: Keeping all the parts: preserving, restoring & sustaining complex ecosystems: Washington, DC: 86th annual meeting; Ecological Society of America: Ecological Society of America; 2001 August 5-10; Madison, WI. 144. Abstract.**

Attainment **Nitrogen (N) deposition and its impact on terrestrial and aquatic ecosystems is a concern facing federal land managers at the Lye Brook Wilderness in Vermont and other protected areas throughout the northeastern United States. Nitrogen production in soils was compared to N concentrations and outputs in leachates to determine how forest cover types differ in regulating N losses. Also, precipitation inputs and modeled estimates of streamwater outputs were used to calculate a watershed N budget. Most ammonium and nitrate were produced in organic soils with deciduous cover. Softwood stands had low net nitrification rates and minimal N leaching. A comparison of watershed inputs and outputs showed a net gain in total dissolved N ($5.5 \text{ kg ha}^{-1} \text{ yr}^{-1}$) due to an accumulation of dissolved inorganic N. The Lye Brook Wilderness ecosystem has N budgets similar to other forested ecosystems in the region, and appears to be assimilating the accumulating N. However seasonal losses of nitrate observed in mineral soils and streamwater may be early warnings of the initial states of N saturation.**

To test the hypothesis that $\delta^{15}\text{N}$ in the forest floor remains constant over time, $\delta^{15}\text{N}$ in forest-floor samples were measured from 1969, 1978, 1987, and 1992 at the reference watershed, at the Hubbard Brook Experimental Forest, New Hampshire. The $\delta^{15}\text{N}$ of the Oa horizon increased significantly from 3.00% in 1969 to 4.89% in 1978, then decreased significantly to 3.81% in 1987 and remained near that level in 1992. In the Oie horizon, $\delta^{15}\text{N}$ increased significantly from 0.17% in 1969 to 0.91% in 1978 and remained at the higher level for the later years. Thus $\delta^{15}\text{N}$ was not at steady state in either the Oie or Oa horizon for the period 1969 to 1992 in the reference watershed. These data suggest that even relatively short-term disruptions of the N cycle (either by anthropogenic or natural disturbance) can alter the $\delta^{15}\text{N}$ in the forest floor, and should be considered in evaluating natural abundance data.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4352

Problem 4 **What are dynamics of community structure, biomass accumulation, and nutrient uptake of northeastern forest ecosystems: how are they effected by disturbances?**

Publications

Cooperative **Smith, Marie-Louis; Martin, Mary E.; Ollinger, S.V.; Hallett, Richard A.; Alber, John D.; Bailey, Scott. 2000. The MAPBGC Project: hyperspectral remote sensing, mapping, and analysis of forest productivity and biogeochemical cycles in the White Mountains, NH. In: Greer, Jerry Dean, ed. Remote sensing and geospatial technologies for the new millennium, proceedings of the eighth Forest Service remote sensing applications conference; 2000 April 10-14; Albuquerque, NM. Bethesda, MD: American Society for Photogrammetry and Remote Sensing.**

Attainment **There is no progress to report at this time.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4352

Problem 5 Synthesize knowledge and long-term data bases to develop guidelines for natural resource managers to protect stream quality, etc.

Publications

Research Hornbeck, James W.; Eagar, Christopher. 2001. A streamwater chemistry database for the White Mountain National Forest. In: Warwick, John J., ed. Water quality monitoring and modeling: proceedings of the AWRA annual spring specialty conference; 2001 April 30-May 2; San Antonio, TX. TPS-01-1. Middleburg, VA: American Water Resources Association: 253-258.

Rustad, Lindsey. 2000. Warming effects on ecosystem functioning. *Global Change and Terrestrial Ecosystem News*. 16: 4-5.

Cooperative Hornbeck, James W.; Kochenderfer, James N. 2000. Forestry effects on water quality. In: Wagner, Robert G.; Hagan, John M., eds. Forestry and the riparian zone: conference proceedings; 2000 October 26; Orono, ME. Orono, ME: University of Maine: 15-18.

Twery, Mark J.; Hornbeck, James W. 2001. Incorporating water goals into forest management decisions at a local level. *Forest Ecology and Management*. 143: 87-93.

Attainment Over the past half century, knowledge about forestry effects on water quality has been gathered through watershed ecosystem research. Such studies, usually conducted on small, experimental watersheds, have shown how contributions of water, sediment, nutrients, heat, and organic matter from forests to streams change as forests undergo succession or experience natural and human-related disturbances. A paper was published which reviews results from past studies and discusses how they can be blended with management practices to protect water quality.

Protection of high quality streamwater requires knowledge of background or baseline data from which to judge impacts of disturbances. Thus a database was assembled for chemical analyses of streamwater samples collected during the past several decades from 446 locations on the White Mountain National Forest (304,000 ha in New Hampshire and Maine). A paper was published which describes the database and uses concentrations of calcium (Ca^{2+}) to illustrate how the data can be used to examine ranges, trends, and relationships. Cumulative frequency curves show that average Ca^{2+} in streams draining forested watersheds free of recent disturbances ranges from 0.5 to 240 $\mu\text{eq/L}$. Half of the locations sampled had average Ca^{2+} concentrations $< 75 \mu\text{eq/L}$. Ca^{2+} in streamwater has gradually declined over the past several decades. A relationship between Ca^{2+} and sulfate (SO_4^{2-}) in streamwater suggests this decline is related to decreases in sulfur emissions and a corresponding decline of SO_4^{2-} in precipitation.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4352

Problem M1 **Hubbard Brook Experimental Forest will be maintained: for forest ecosystem research; as Biosphere Reserve.**

Publications

Research **Martin, Wayne C.; Hornbeck, James W.; Likens, Gene E.; Buso, Donald C. 2000. Impacts of intensive harvesting on hydrology and nutrient dynamics of northern hardwood forests. Canadian Journal of Fisheries and Aquatic Sciences. 57(2): 19-29.**

Cooperative **Campbell, John L.; Hornbeck, James W.; McDowell, William H.; Likens, Gene E.; Buso, Donald C.; Shanley, James B. 2000. Fluxes of dissolved organic carbon from 8 forested watersheds in New England. In: American Geophysical Union 2000 fall meeting; 2000 December 15-19; San Francisco, CA. Washington, DC: American Geophysical Union. Abstract.**

Extramural **Buso, Donald C.; Likens, Gene E.; Eaton, John S. 2000. Chemistry of precipitation, streamwater, and lakewater from the Hubbard Brook Ecosystem Study: a record of sampling protocols and analytical procedures. In: Gen. Tech. Rep. NE-275. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 52.**

Gbondo-Tugbawa, Solomon S.; Driscoll, Charles T. 2001. Evaluation of an integrated biogeochemical model (PnET-BGC) at a northern hardwood forest ecosystem. Water Resources Research. 37(4)April: 1057-1070.

Attainment **Whole-tree clear-cutting and progressive strip-cutting of northern hardwood forests at the Hubbard Brook Experimental Forest in central New Hampshire resulted in measurable changes in physical and chemical conditions of forest streams. As a result of reduced transpiration and interception, water yield for the first year after whole-tree harvesting increased by >150 mm, the majority of which occurred during the growing season. Peak flows increased only moderately. Water yield and peak flow increases disappeared within 4-6 years as a result of rapidly regrowing vegetation. Sediment yields increased during and after harvesting but can be maintained within normal ranges of reference streams by careful use of best management practices. Stream chemistry changes occurred immediately following harvesting, most notably in the form of increases in concentrations of Ca^{2+} , K^{+} , NO_3^{-} , and H^{+} . The concentrations return close to preharvest levels within 3-5 years. A paper was published in which these changes were discussed in terms of their causes and implications for aquatic habitat and fisheries.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4352

Attainment. The Hubbard Brook Ecosystem Study is an on-going, long-term effort to understand the structure and function of forest watersheds and associated aquatic ecosystems at the Hubbard Brook Experimental Forest in New Hampshire. Chemical analyses of streamwater and precipitation collections began in 1963, and analyses of lakewater collections began in 1967. A paper was published which documents these collection methods, sites, and analytical techniques, providing a complete record to ensure the integrity of HBES data. The evolution of the HBES chemical data management system and the development of quality assurance procedures are described, as is the general algorithm by which ecosystem chemical inputs and outputs are calculated. These data represent a unique and important contribution to ecosystem science and provide an internationally recognized benchmark for assessing ecological changes.

The Hubbard Brook Ecosystem Study is an on-going, long-term effort to understand the structure and function of forest watersheds and associated aquatic ecosystems at the Hubbard Brook Experimental Forest in New Hampshire. Chemical analyses of streamwater and precipitation collections began in 1963, and analyses of lakewater collections began in 1967. A paper was published which documents these collection methods, sites, and analytical techniques, providing a complete record to ensure the integrity of HBES data. The evolution of the HBES chemical data management system and the development of quality assurance procedures are described, as is the general algorithm by which ecosystem chemical inputs and outputs are calculated. These data represent a unique and important contribution to ecosystem science and provide an internationally recognized benchmark for assessing ecological changes.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4353

Sustainable Forest Ecosystems in the Central Appalachians
Adams, Mary Beth, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Fundin g (\$1,000)	Current Staffing (Scientist years)	Research Unit	Research Outputs	
				Extramural	Cooperative
1. Information is needed on historical disturbance patterns and influences on ecosystem processes.	58	.3	1	0	1
2. Quantitative information is needed about important ecosystem processes and impact of disturbances.	566	2.4	1	2	2
3. Efficient and ecologically sound silvicultural alternatives must be developed to meet complex management objectives and provide for sustainable production and availability of many forest benefits.	567	2.2	2	13	1
4. Develop guidelines for a variety of management and operation practices and develop tools to monitor, evaluate and mitigate impacts on soil productivity, water quality and quantity.	113	.2	0	0	0

NORTHEASTERN RESEARCH STATION
Research Unit NE-4353

Problem 1 **Information is needed on historical disturbance patterns and influences on ecosystem processes.**

Publications

Research **Schuler, Thomas M.; Ford, William Mark; Collins, Rachel. 2001. Successional dynamics and management implications of a montane coniferous forest in the central Appalachians. In: Young, Louise, ed. Issues of scale-from theory to practice: 3rd North American forest ecology workshop program; 2001 June 24-27; Duluth, MN. Duluth, MN: University of Minnesota: 95. Abstract.**

Attainment **The following reflects major accomplishments for the life of this problem. Long-term temporal patterns of species diversity in a central Appalachian mixed forest were documented, and analyzed with respect to time and different disturbance regimes. Diversity has declined, due to a variety of disturbances. Successional dynamics of red spruce were quantified for an isolated stand in West Virginia. These data, along with other information were used in simulation exercises to test management strategies for a variety of uses, including providing habitat for threatened and endangered species.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4353

- Problem 2** Quantitative information is needed about important ecosystem processes and impacts of disturbances.
- Publications**
- Research** Adams, M.B.; Owens, D.R. 2001. Specific gravity of coarse woody debris for some central Appalachian hardwood forest species. Res. Pap. NE-716. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 4.
- Cooperative** Adams, M.B.; Burger, J.A.; Jenkins, A.B.; Zelazny, L. 2000. Impact of harvesting and atmospheric pollution on nutrient depletion of eastern US hardwood forests. *Forest Ecology and Management*. 138: 301-319.
- Angradi, Ted R.; Hagan, Stacey M.; Able, Kenneth W. 2001. Vegetation type and the intertidal macroinvertebrate fauna of a brackish marsh: *Phragmites* vs. *Spartina*. *Wetlands*. 21(1): 75-92.
- Hornbeck, James W.; Kochenderfer, James N. 2000. Forestry effects on water quality. In: Wagner, Robert G.; Hagan, John M., eds. *Forestry and the riparian zone: conference proceedings*; 2000 October 26; Orono, ME. Orono, ME: University of Maine: 15-18.
- Extramural** Buzby, Karen M.; Perry, Sue A. 2000. Modeling the potential effects of climate change on leaf pack processing in central Appalachian streams. *Canadian Journal of Fisheries and Aquatic Sciences*. 57: 1773-1783.
- Odom, Richard H.; Ford, W. Mark; Edwards, John W.; Stihler, Craig W.; Menzel, Jennifer M. 2001. Developing a habitat model for the endangered Virginia northern flying squirrel (*Glaucomys sabrinus fuscus*) in the Allegheny Mountains of West Virginia. *Biological Conservation*. 99: 245-252.
- Attainment** Significant progress was made in our understanding of ecosystems and non-commodity uses of forests. In cooperation with another FS scientist, an excellent review of *Forestry Effects on Water Quality* was presented at a major conference and published, synthesizing a half century of watershed ecosystem research. A habitat model was developed for an endangered flying squirrel which should prove useful in developing management options. The role of coarse woody debris in second growth Appalachian forests was further elucidated. The interaction of atmospheric pollution and timber harvesting on soil nutrient capital was explored.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4353

Problem 3 Efficient and ecologically sound silvicultural alternatives must be developed to meet complex management objectives and provide for sustainable production and availability of many forest benefits.

Publications

Research Ford, W. Mark; Menzel, Michael A.; McCay, Timothy S.; Laerm, Joshua. 2001. Contiguous allopatry of the masked shrew and southeastern shrew in the southern Appalachians: segregation along an elevational and habitat gradient. *Journal of the Elisha Mitchell Scientific Society*. 117(1): 20-28.

Rodrique, Jane L.; Schuler, Thomas M.; Menzel, Michael A. 2001. Observations of bat activity during prescribed burning in West Virginia. *Bat Research News*. 42(2): 48-49.

Cooperative Ford, W. Mark; Menzel, Michael A.; McCay, Timothy S.; Odom, Richard H. 2001. Southern Appalachian coves and sorcid abundance: an examination of patch dynamics in a forested landscape. In: Young, Louise, ed. *Issues of scale-from theory to practice: 3rd North American forest ecology workshop program; 2001 June 24-27; Duluth, MN. Duluth, MN: University of Minnesota: 49. Abstract.*

Miller, Gary W.; Kochenderfer, James N.; Knibbs, James; Baumgras, John E. 2001. Vegetative conditions and management options in even-age stands on the Monongahela National Forest. In: Barras, Stan J., ed. *Proceedings: national silvicultural workshop; 1999 October 5-7; Kalispell, MT. RMRS-P-19. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 40-47.*

Extramural Campbell, Tyler; Laseter, Benjamin; Osborn, David; Bush, Parshall; Miller, Karl; Ford, W. Mark. 2001. Unusual summer movements of white-tailed deer in the Central Appalachians-is it in the water? In: 24th annual meeting of the Southeast Deer Study Group; 2001 February 18-21; St. Louis, MO. [Place of publication unknown]: [Publisher name unknown]: 14-15. Abstract.

Castleberry, Nicole L.; Castleberry, Steven B.; Ford, W. Mark; Wood, Petra B.; Mengak, Michael T. 2001. Summer microhabitat selection by foraging Allegheny woodrats in a managed forest. In: Sixth annual meeting of the Southeastern Bat Diversity Network and 11th annual colloquium on conservation of mammals in the southeastern United States; 2001 February 22-23; Memphis, TN. Memphis, TN: University of Memphis, Abstract.

Castleberry, Steven B.; Ford, W. Mark; Wood, Petra B.; Castleberry, Nikole L.; Mengak, Michael T. 2001. Movements of Allegheny woodrats in relation to timber harvesting. *Journal of Wildlife Management*. 65(1): 148-156.

Castleberry, Steven B.; King, Timothy L.; Ford, W. Mark; Wood, Petra B.; Castleberry, Nikole. 2001. Microsatellite DNA analysis of Allegheny woodrat population structure. In: Sixth annual meeting of the Southeastern Bat Diversity Network and 11th annual colloquium on conservation of mammals in the southeastern United States; 2001 February 22-23; Memphis, TN. Memphis, TN: University of Memphis. Abstract.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4353

- Extramural** **Edwards, John W.; Ford, W. Mark; Wood, Petra B.; Menzel, Michael A.; Johnson, Josh B.; Owen, Sheldon F. 2001. Survey of forest bat communities on the Monongahela National Forest and Westvaco Wildlife Ecosystem Research Forest. [Place of publication unknown]: [Publisher name unknown]. 119.**
- Ford, W. Mark; Menzel, Michael A.; McCay, Timothy S.; Odom, Richard H. 2001. Coves as habitat islands and soricids: the shrew project uncomfortably greets the 21st century. In: Sixth annual meeting of the Southeastern Bat Diversity Network and 11th annual colloquium on conservation of mammals in the southeastern United States; 2001 February 22-23; Memphis, TN. Memphis, TN: University of Memphis. Abstract.**
- Johnson, Joshua B.; Menzel, Michael A.; Edwards, John W.; Ford, W. Mark. 2001. Spatial activity patterns of gray bats (*Myotis grisescens*) in northwest Georgia. In: Sixth annual meeting of the Southeastern Bat Diversity Network and 11th annual colloquium on conservation of mammals in the southeastern United States; 2001 February 22-23; Memphis, TN. Memphis, TN: University of Memphis. Abstract.**
- Menzel, M. Alex; Chapman, Brian R.; Ford W. Mark; Menzel, Jennifer M.; Laerm, Joshua. 2000. A review of the distribution and roosting ecology of bats in Georgia. Georgia Journal of Science. 58(3): 143-178.**
- Menzel, Michael A.; Carter, Timothy C.; Ford, W. Mark; Chapman, Brian R. 2001. Tree-roost characteristics of subadult and female adult evening bats (*Nycticeius humeralis*) in the Upper Coastal Plain of South Carolina. American Midland Naturalist. 145: 112-119.**
- Menzel, Michael A.; Johnson, Josh B.; Menzel, Jennifer M.; Edwards, John W.; Ford W. Mark. 2000. Possible ground roost of the silver-haired bat *Lasionycteris noctivagans*. Bat Research News. 41(4): 103.**
- Menzel, Michael A.; McCracke, Gary F.; Ford, W. Mark; Edwards, John W.; Kilgo, John C.; Menzel, Jennifer M. 2001. The effect of harvest and regeneration of pine forests in the southeastern United States on the spatial activity patterns of bats. In: Sixth annual meeting of the Southeastern Bat Diversity Network and 11th annual colloquium on conservation of mammals in the southeastern United States; 2001 February 22-23; Memphis, TN. Memphis, TN: University of Memphis. Abstract.**
- Menzel, Michael A.; Menzel, Jennifer M.; Edwards, John W.; Carter, Timothy C.; Churchill, John B.; Kilgo, John C. 2001. Home range and habitat use of male Rafinesque's big-eared bats (*Corynorhinus rafinesquii*). American Midland Naturalist. 145(2): 402-408.**
- Owen, Sheldon F.; Menzel, Michael A.; Ford W. Mark; Chapman, Brian R.; Miller, Karl V.; Edwards, John; Wood, Petra Bohall. 2001. Home-range size and habitat use of the northern long-eared *Myotis* in an industrial forest landscape in the central Appalachians. In: Sixth annual meeting of the southeastern bat diversity network and 11th annual colloquium on conservation of mammals in the southeastern United States; 2001 February 22-23; Memphis, TN, Memphis, TN: University of Memphis. Abstract.**

NORTHEASTERN RESEARCH STATION

Research Unit NE-4353

Attainment A comprehensive survey of even-aged stands regenerated between 1964 and 1990 was conducted. Preliminary results suggest that clearcutting was successful in regenerating diverse hardwood stands. Our understanding of bat populations and activities was greatly increased. The first summer record of a female Indiana bat (*Myotis sodalis*) in West Virginia was noted. Observations on bat activity during prescribed burning were published. The home range and habitat use of male Rafinesque's big eared bats were documented. The habits and activity patterns of a number of southern bats were also documented. Our understanding of other potentially sensitive mammals (Allegheny woodrats, Virginia northern flying squirrels, shrews and white-tailed deer) as affected by silvicultural operations was also increased.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4353

Problem 4 **Develop guidelines for a variety of management and operation practices and develop tools to monitor, evaluate and mitigate impacts on soil productivity, water quality and quantity.**

Publications

Research **Edwards, Pamela J.; Kochenderfer, James N. 2001. Using specific conductance to predict stream water chemistry during storms. In: Warwick, John J., ed. Water quality monitoring and modeling: proceedings of the AWRA annual spring specialty conference; 2001 April 30-May 2; San Antonio, TX. TPS-01-1. Middleburg, VA: American Water Resources Association: 225-230.**

Extramural **Langdon, Christopher; Edwards, John; Crum, James; Ford, W. Mark. 2001. A comparison of white-tailed deer (*Odocoileus virginianus*) population estimation methods in West Virginia. In: 24th annual meeting of the Southeast Deer Study Group; 2001 February 18-21; St. Louis, MO. [Place of publication unknown]; [Publisher name unknown]; 21. Abstract.**

Webb, J.R.; Adams, M.B.; Galloway, J.N.; Van Miegroet, H.; Swank, W.T. 1999. Southern Appalachian mountain region. In: Integrating the nation's environmental monitoring and research programs: an exercise using nitrogen enrichment to demonstrate the value of index sites in a national network. [Place of publication unknown]: [Publisher name unknown]: 42-46.

Attainment **A diversity of monitoring methods was evaluated. For estimating white-tailed deer populations, the mark-recapture method using an automated camera provided the most reliable estimates. Specific conductance was found to be a relatively simple way to predict stream water chemistry in stormflow. The values of index sites, including experimental forests, for evaluating environmental impacts has been demonstrated relative to the problem of nitrogen enrichment.**

NORTHEASTERN RESEARCH STATION

Research Unit NE-4454

Integrating social and biophysical sciences for natural resource management.
Twery, Mark J, Project Leader

**FY 2001 Research Attainments
Research Unit Summary**

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Unit	Research Outputs	
				Extramural	Cooperative
1. Social structures and processes: Resource managers need an improved understanding of the relationships among social institutions and organizations, forest management, and forest ecosystem processes to achieve their policy and management goals.	242	2	3	0	0
2. Values and decision making: Natural resource managers need a better understanding of key human values that affect natural resource decisions and better tools for analyzing and evaluating alternative policies and management actions, particularly those involving multiple goals and diverse stakeholder objectives..	313	2	4	1	1
3. Management applications: Natural resource managers face critical information gaps about an array of human social values regarding timber management, recreation, special forest products and biodiversity and the interactions of these values with management.	181	1	3	0	1
4. Tool development: There is a need for decision support tools that integrate the best knowledge available about biophysical and social systems and assist managers and policy makers in using this knowledge to make decisions.	480	1	3	1	3

NORTHEASTERN RESEARCH STATION
Research Unit NE-4454

Problem 1 **Social structures and processes: resource managers need an improved understanding of the relationships among social institutions and organizations, forest management, and forest ecosystem processes to achieve their policy and management goals.**

Publications

Research **Grove, J. Morgan. 2001. Cause and consequence: the social dimensions of ecosystem restoration. In: Therres, Glenn E., ed. Proceedings of the conference: Conservation of biological diversity: a key to the restoration of the Chesapeake Bay ecosystem and beyond; 1998 May 10-13; Annapolis, MD. Annapolis, MD: Maryland Department of Natural Resources: 27-41.**

Grove, J. Morgan; Kinzig, Ann P. 2001. Synthesis of social and ecological approaches for the spatial analyses of human ecosystems, with examples from Phoenix, Arizona, and Baltimore, Maryland. In: Pattern, process, scale, and hierarchy: interactions in human-dominated and natural landscapes: the 16th annual symposium of the U.S. Regional Association of the International Association of Landscape Ecology; 2001 April 25-29; Phoenix, AZ. Phoenix, AZ: University of Arizona: 128. Abstract.

Kinzig, Ann P.; Grove, J. Morgan. 2001. Urban-suburban ecology. In: Encyclopedia of Biodiversity. Vol. 5. New York, NY: Academic Press: 733-746.

Attainment **We continue to develop strong theoretical works on the relationships of social institutions and processes to the ecosystem within which they operate, from central urban environments to remote rural areas. Additional publications on the relationships of communities to their ecological surroundings demonstrate the basis for the theoretical work. We have documented the attitudes of non-industrial private forest landowners toward ecosystem management and identified the effects that these attitudes may have on implementation of landscape or regional management goals. We have published an account of the social dimensions of ecological restoration and the influence of societal attitudes on the success of restoration efforts. Through publication of a chapter on urban and suburban ecology in a new encyclopedia of biodiversity, we have added a major contribution to the understanding of the interactions between people and their environment.**

NORTHEASTERN RESEARCH STATION

Research Unit NE-4454

Problem 2 Values and decision making: Natural resource managers need a better understanding of key human values that affect natural resource decisions and better tools for analyzing and evaluating alternative policies and management actions, particularly those involving multiple goals and diverse stakeholder objectives.

Publications

- Research** Dennis, Donald F. 2000. Analyzing multiple objective decisions on public lands. In: Vasievich, J. Michael; Fried, Jeremy S.; Leefers, Larry A., eds. Seventh symposium on systems analysis in forest resources; 1997 May 28-31; Traverse City, MI. Gen. Tech. Rep. NC-205. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 205-209.
- Dennis, Donald F.; Stevens, Thomas H.; Kittredge, David B. 2001. Estimating relative values for multiple objectives on private forests. In: Kyle, Gerard, comp., ed. Proceedings of the 2000 northeastern recreation symposium; 2000 April 2-4; Bolton Landing, NY. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 64-67.
- More, Thomas A.; Averill, James R.; Stevens, Thomas H. 2000. How valid are future generations' arguments for preserving wilderness? In: McCool, Stephen F.; Cole, David N.; Borrie, William T.; O'Loughlin, Jennifer, comps. Wilderness science in a time of change conference-volume 2: wilderness within the context of larger systems; 1999 May 23-27; Missoula, MT. RMRS-P-15-Vol-2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 81-85.
- More, Thomas A.; Twery, Mark J. 2001. The Forest Service's recreation agenda: comments on the roles of research and state and private forestry in the Northeast. In: Kyle, Gerard, comp., ed. Proceedings of the 2000 northeastern recreation research symposium; 2000 April 2-4; Bolton Landing, NY. Gen. Tech. Rep. NE-276/ Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 273-275.
- Cooperative** Dennis, Donald F.; Sendak, Paul E.; McEvoy, Thom J. 2000. Analysis of timber prices in New England. In: Vasievich, J. Michael; Fried, Jeremy S.; Leefers, Larry A., eds. Seventh symposium on systems analysis in forest resources; 1997 May 28-31; Traverse City, MI. Gen. Tech. Rep. NC-205. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 450-452.
- Extramural** More, Thomas A.; Steering Committee. 2001. In: Kyle, Gerard, comp., ed. Proceedings of the 2000 northeastern recreation research symposium; 2000 April 2-4; Bolton Landing, NY. Gen. Tech. Rep. NE-276. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 307.
- Attainment** We continue to produce information on how publics value various resources from their public lands, and what tradeoffs they are willing to make. Additional new publications on attitudes of private landowners to managing for shared benefit and for the common good are making an impact on the field.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4454

Attainment We have published extensively on user fees and their relationship to fair distribution of use of public lands. These publications have stimulated intense national discussions on the topic. We have demonstrated the importance of wilderness as a value that people want from their forest lands. Additional work on the value of parks continues to provide managers with important information. Values desired from private lands through jointly developed ecosystem management goals and techniques have been derived from our current work.

Additional publications on recreation, including a compilation representing recreation research throughout the Northeast and an assessment of the National Forests' recreation agenda are providing managers with useful information.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4454

Problem 3 Management applications: Natural resource managers face critical information gaps about an array of human social values regarding timber management, recreation, special forest products and biodiversity and the interactions of these values with management.

Publications

Research Doble, Siri; Emery, Marla. 2001. The role of nontimber forest products: a case study of gatherers in the eastern United States. In: Kyle, Gerard, comp., ed. Proceedings of the 2000 northeastern recreation research symposium; 2000 April 2-4; Bolton Landing, NY. Gen. Tech. Rep. NE-276. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 53-57.

Emery, Marla R. 2001. Gatherers, practices, and livelihood roles of non-timber forest products. Fact sheet no. 6. Blacksburg, VA: Virginia Polytechnic Institute and State University, Department of Wood Science and Forest Products: 5.

Emery, Marla R. 2001. Non-timber forest products and livelihoods in Michigan's Upper Peninsula. In: Davidson-Hunt, Iain; Duchesne, Luc C.; Zasada, John C., eds. Forest communities in the third millennium: linking research, business, and policy toward a sustainable non-timber forest product sector; Kenora, ON. Gen. Tech. Rep. NC-217. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 23-30.

Emery, Marla R. 2001. Who knows? Local non-timber forest product knowledge and stewardship practices in northern Michigan. *Journal of Sustainable Forestry*. 13(3/4): 123-129.

Emery, Marla.; McLain, Rebecca J., eds. 2001. Non-timber forest products: medicinal herbs, fungi, edible fruits and nuts, and other natural products from the forest. *Journal of Sustainable Forestry*. 165p.

Emery, Marla.; O'Halek, Shandra, L. 2001. Brief overview of historical non-timber forest product use in the U.S. Pacific Northwest and Upper Midwest. *Journal of Sustainable Forestry*. 13(3/4): 25-30.

McLain, Rebecca J.; Emery, Marla. 2001. Introduction. *Journal of Sustainable Forestry*. 13(3/4): 1-4.

Rechlin, Mike; Twery, Mark J.; Wade, Gary; Storey, Mike. 2000. The other half of a "forever wild" park: education and research at the Adirondack Visitor Interpretive Center. *Adirondack Journal of Environmental Studies*. 7(2): 5-11.

Cooperative LeDoux, Chris B.; Sendak, Paul E.; McWilliams, William H.; Huyler, Neil; Malecek, Thomas; Muzzey, Worthen; Jones, Toni. 2001. Timber supply and demand assessment of the Green and White Mountain National Forests' market area. In: Gen. Tech. Rep. NE-280. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 19.

Muzika, R.M.; Liebhold, A.M.; Twery, M.J. 2000. Dynamics of twolined chestnut borer *Agrilus bilineatus* as influenced by defoliation and selection thinning. *Agricultural and Forest Entomology*. 2: 283-289.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4454

Attainment We have developed extensive information on how people use the forested environment to support their livelihoods in rural, poor communities. We have published extensive case studies and analyses of the use of non-timber forest products throughout the United States, including descriptions of the kinds of knowledge retained in different segments of the population. We continue to develop and refine our understanding of how ecological relationships vary across scales from individual stands to landscape and regional levels. Restoration of ecosystem function on abandoned surface mines is an important problem for which we have provided needed information. Additional work on scale-dependent analysis of human-dominated ecosystems, such as Baltimore, MD, is producing new information on how human and "natural" ecosystems are actually an integrated whole. We are improving our knowledge of silvicultural treatments and their effects on the entire forest community, including understory vegetation and human recreationists.

NORTHEASTERN RESEARCH STATION

Research Unit NE-4454

Problem 4 **Tool development:** There is a need for decision support tools that integrate the best knowledge available about biophysical and social systems and assist managers and policy makers in using this knowledge to make decisions.

Publications

Research Schweik, Charles M.; Grove, J. Morgan. 2001. Fostering open-source research via a world wide web system. In: Available: <http://www.opensource.org>. Abstract.

Twery, Mark J. 2000. The NED family of software for forest management. *Pennsylvania Forests*. 91(4): 5-7.

Twery, Mark J. 2001. Helping resource expertise meet people's needs: the NED set of software. In: Therres, Glenn E., ed. *Proceedings of the conference: Conservation of biological diversity: a key to the restoration of the Chesapeake Bay ecosystem and beyond*; 1998 May 10-13; Annapolis, MD. Annapolis, MD: Maryland Department of Natural Resources: 42-47.

Cooperative Bi, W.; Potter, W.D.; Twardus, D.; Thistle, H.; Twery, M.J.; Ghent, J.; Teske, M. 2000. Aerial spray optimization. In: Arabnia, H.R., ed. *Proceedings of the international conference on artificial intelligence: IC-AI'2000*, Vol. I; 2000 June 26-29; Las Vegas, NV. Las Vegas, NV: CSREA Press: 473-479.

Rauscher, H. Michael; Spearman, John E., Jr.; Fout, C. Preston; Giles, Robert H., Jr.; Twery, Mark J. 2001. Talking high-tech turkey. *Tree Farmer*. 20(3): 6-9, 13.

Twery, Mark J.; Hornbeck, James W. 2001. Incorporating water goals into forest management decisions at a local level. *Forest Ecology and Management*. 143: 87-93.

Extramural Wei, Yong. 2000. KET: a knowledge base engineering tool for the forest health expert system. Athens, GA: University of Georgia: 53p. M.S. thesis.

Attainment Progress this year includes distribution of hundreds of copies of software to promote better-informed decision making for ecosystem management. New software developed explores the methodology of analyzing multi-resource decisions and assists managers in balancing objectives. We have also begun distribution of a new software program to assist in development of stewardship plans for management of non-industrial private lands. A better understanding of how goals for management can be constructed and how they may be interrelated has resulted from our work this year. Additional research into using a genetic algorithm to determine the best combination of spray equipment has produced information of great use to aerial applicators. We have also developed and published on an open-source system for managing data over the World Wide Web, and the system is in use across many research efforts throughout the eastern United States.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4455

Global Change Research Program
Birdsey, Richard A, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Unit	Research Outputs	
				Extramural	Cooperative
1. Global Change Research	1,833	3.3	3	17	1
2. Global Change Research (cont'd)	0	0	3	3	13

NORTHEASTERN RESEARCH STATION
Research Unit NE-4455

Problem 1 Global Change Research.

Publications

- Research** **Brown, Sandra; Iverson, Louis R.; Prasad, Anantha. 2001. Geographical distribution of biomass carbon in tropical southeast Asian forests: a database. ORNL/CDIAC-119; NDP-068. Oak Ridge, TN: U.S. Department of Energy, Oak Ridge National Laboratory, Carbon Dioxide Information Analysis Center: 75.**
- Emery, Marla R. 2001. Non-timber forest products and livelihoods in Michigan's Upper Peninsula. In: Davidson-Hunt, Iain; Duchesne, Luc C.; Zasada, John C., eds. Forest communities in the third millennium: linking research, business, and policy toward a sustainable non-timber forest product sector; Kenora, ON. Gen. Tech. Rep. NC-217. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 23-30.**
- Emery, Marla R. 2001. Who knows? Local non-timber forest product knowledge and stewardship practices in northern Michigan. Journal of Sustainable Forestry. 13(3/4): 123-129.**
- Emery, Marla.; O'Halek, Shandra, L. 2001. Brief overview of historical non-timber forest product use in the U.S. Pacific Northwest and Upper Midwest. Journal of Sustainable Forestry. 13(3/4): 25-30.**
- Iverson, Louis R.; Prasad, Anantha. 2001. Potential changes in tree species richness and forest community types following climate change. Ecosystems. 4: 186-199.**
- Jenkins, Jennifer; Birdsey, Richard A.; Murdoch, Peter; Hom, John. 2001. Integrated environmental monitoring and assessment: In: Keeping all the parts: preserving, restoring, and sustaining complex ecosystems. The Ecological Society of America 86th annual meeting; 2001 August 5-10; Madison, WI. Washington, DC: The Ecological Society of America. Abstract.**
- Pan, Yude. 2000. Plant functional types: Their relevance to ecosystem properties and global change. Ecological Engineering. 16(2): 305-307.**
- Pan, Yude. 2000. Review of plant functional types: their relevance to ecosystem properties and global change. Ecological Engineering. 16(2): 305-307.**
- Pan, Yude.; Melillo, J.M.; Kicklighter, D.W.; Xiang Xiao-Ming; McGuire, A.D. 2001. Modeling structural and functional responses of terrestrial ecosystems in China to changes in climate and atmospheric CO₂. Acta Phytoecologica Sinica. 25(2): 175-189.**
- Perkins, T.D.; Wong, B.L.; Wimot, T.R.; Bagget, K.L. 2000. Ice storm effects on stored carbohydrates in sugar maple. In: Perkins, T.D., ed. Proceedings of the Maple 2000 conference, International Maple Syrup Institute and North American Maple Syrup Council annual meetings; 2000 October 25-28; Burlington, VT. Underhill Center, VT: The University of Vermont, Proctor Maple Research Center: 16. Poster abstract.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4455

- Research** Wong, B.L.; Baggett, K.L.; Burfiend, A.J.; Rye, S.H. 2000. Starch and soluble sugar levels during the leafless period in sugar maples with crown dieback. In: Perkins, T.D., ed. Proceedings of the Maple 2000 conference, International Maple Syrup Institute and North American Maple Syrup Council annual meetings; 2000 October 25-28; Burlington, VT. Underhill Center, VT: The University of Vermont, Proctor Maple Research Center: 15. Poster abstract.
- Wong, B.L.; Baggett, K.L.; Rye, A.H.; Burfiend, A.S.; Staats, L.J. 2000. Fall/winter carbohydrate reserves in sugar maples after the January 1998 ice storm in northern New York. In: Perkins, T.D., ed. Proceedings of the Maple 2000 conference, International Maple Syrup Institute and North American Maple Syrup Council annual meetings; 2000 October 25-28; Burlington, VT. Underhill Center, VT. The University of Vermont: Proctor Maple Research Center. 15. Poster abstract.
- Cooperative** Birdsey, Richard A.; Heath, Linda S. 2001. Forest inventory data, models, and assumptions for monitoring carbon flux. In: Soil carbon sequestration and the greenhouse effect. SSSA spec. publ. no. 57. Madison, WI: Soil Science Society of America: 125-135.
- Brooks, Robert T. 2000. Annual and seasonal variation and the effects of hydroperiod on benthic macroinvertebrates of seasonal forest ("vernal") ponds in central Massachusetts, USA. *Wetlands*. 20(4): 707-715.
- Heath, Linda S.; Chojnacky, David. 2001. Down dead wood statistics for Maine timberlands, 1995. *Resour. Bull. NE-150*. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 80.
- Rustad, L.E.; Campbell, J.L.; Marion, G.M.; Norby, R.J.; Mitchell, M.J.; Hartley, A.E. 2001. A meta-analysis of the response of soil respiration, net nitrogen mineralization, and aboveground plant growth to experimental ecosystem warming. *Oecologia*. 126: 543-562.
- Smith, James E.; Heath, Linda S. 2001. Identifying influences on model uncertainty: an application using a forest carbon budget model. *Environmental Management*. 27(2): 253-267.
- Extramural** Bhatnagar, Pratiksha; Glasheen, Bernadette M.; Bains, Suneet K.; Long, Stephanie L.; Minocha, Rakesh; Walter, Christian. 2001. Transgenic manipulation of the metabolism of polyamines in poplar cells. *Plant Physiology*. 125: 2139-2153.
- Buzby, Karen M.; Perry, Sue A. 2000. Modeling the potential effects of climate change on leaf pack processing in central Appalachian streams. *Canadian Journal Fish. Aquat. Sci.* 57: 1773-1783.
- Caspersen, John P.; Pacala, Stephen W.; Jenkins, Jennifer C.; Hurtt, George C.; Moorcroft, Paul R.; Birdsey, Richard A. 2000. Contributions of land-use history to carbon accumulation in U.S. forests. *Science*. 290: 1148-1151.
- Karnosky, D.F.; Mankovska, B.; Percy, K.; Dickson, R.E.; Podila, G.K.; Sober, J. 1999. Effects of tropospheric O₃ on trembling aspen and interaction with CO₂: results from an O₃-gradient and a FACE experiment. *Water, Air, and Soil Pollution*. 116: 311-322.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4455

- Extramural** King, J.S.; Pregitzer, K.S.; Zak, D.R.; Sober, J.; Isebrands, J.S.; Dickson, R.E. 2001. Fine-root biomass and fluxes of soil carbon in young stands of paper birch and trembling aspen as affected by elevated atmospheric CO₂ and tropospheric O₃. *Oecologia*. 128: 237-250.
- King, John S.; Pregitzer, Kurt S.; Zak, Donald R.; Kubiske, Mark E.; Ashby, Jennifer A.; Holmes, William E. 2001. Chemistry and decomposition of litter from *Populus tremuloides* Michaux grown at elevated atmospheric CO₂ and varying N availability. *Global Change Biology*. 7: 65-74.
- Noormets, A.; Sober, A.; Pell, E.J.; Dickson, R.E.; Podila, G.K.; Sober, J.; Isebrands J.G.; Karnosky, D.F. 2001. Stomatal and non-stomatal limitation to photosynthesis in two trembling aspen (*Populus tremuloides* Michx.) clones exposed to elevated CO₂ and/or O₃. *Plant, Cell and Environment*. 24: 327-336.
- Noormets, Asko; McDonald, Evan P.; Dickson, Richard E.; Kruger, Eric L.; Sober, Anu; Isebrands, J.G.; Karnosky, David F. 2001. The effect of elevated carbon dioxide and ozone on leaf- and branch-level photosynthesis and potential plant-level carbon gain in aspen. *Trees*. 15: 262-270.
- Noormets, Asko; Podila, G. Krishna; Karnosky, David F. 2000. Rapid response of antioxidant enzymes to O₃-induced oxidative stress in *Populus tremuloides* clones varying in O₃ tolerance. *Forest Genetics*. 7(4): 335-338.
- Pacala, S.W.; Hurtt, G.C.; Baker, D.; Peylin P.; Houghton, R.A.; Birdsey, Richard A. 2001. Consistent land- and atmosphere-based U.S. carbon sink estimates. *Science*. 292: 2316-2320.
- Ratray, Gordon; Sievering, Herman. 2001. Dry deposition of ammonia, nitric acid, ammonium, and nitrate to alpine tundra at Niwot Ridge, Colorado. *Atmospheric Environment*. 35: 1105-1109.
- Shaver, Gaius R.; Canadell, Josep; Chapin III, F.S.; Gurevitch, Jessica; Harte, John; Henry, Greg. 2000. Global warming and terrestrial ecosystems: a conceptual framework for analysis. *BioScience*. 50(10): 871-882.
- Shaver, Gaius R.; Canadell, Josep; Chapin, F.S. III; Gurevitch, Jessica; Harte, John; Henry, Greg; Ineson, Phil; Jonasson, Sven; Melillo, Jerry; Pitelka, Louis; Rustad, Lindsey. 2000. Global warming and terrestrial ecosystems: a conceptual framework for analysis. *BioScience*. 50(10): 871-882.
- Sievering, H.; Kelly, T.; McConville, G.; Seibold, C.; Turnipseed, A. 2001. Nitric acid dry deposition to conifer forests: Niwot Ridge spruce-fir-pine study. *Atmospheric Environment*. 35: 3851-3859.
- Sievering, Herman; Fernandez, Ivan; Lee, John; Hom, John; Rustad, Lindsey. 2000. Forest canopy uptake of atmospheric nitrogen deposition at eastern U.S. conifer sites: Carbon storage implications? *Global Biogeochemical Cycles*. 14(4): 1153-1159.
- Xiao, Xiangming; Vorosmarty, Charles J.; Melillo, Jevy M.; Kicklighter, David W.; Tian, Hanqin.; McGuire, A. David. 1999. Transient climate change and potential croplands of the world in the 21st century. *Sistema Terra*. 8: 96-109.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4455

Extramural Yarie, John. 2000. Boreal forest ecosystem dynamics. I. A new spatial model. Canadian Journal for Forest Research. 30: 998-1009.

Yarie, John. 2001. Boreal forest ecosystem dynamics. II. Application of the model to four vegetation types in interior Alaska. Canadian Journal for Forest Research. 30: 1010-1023.

Yin, Xiwei. 2000. Surface wind speed over land: A global view. Journal of Applied Meteorology. 39: 1861-1865.

Attainment The Northern Global Change Research Program addresses the effects of physical and chemical climate change on the health and productivity of forested lands, and opportunities to mitigate or adapt to global change. Research priorities include: forest-atmosphere interactions; physiological response to atmospheric change and multiple stress; nutrient cycling and hydrologic response to acidic deposition; ecosystem process modeling; and regional and national analysis for management and policy.

Forest Inventory and Analysis (FIA) data was used to reveal the historic causes of changes in forest carbon stocks, primarily land use. These estimates were reconciled with atmospheric measurements, resolving a controversy that cast doubt on the credibility of forest monitoring programs. These advances in carbon cycle science are highly relevant to formulation of national policy regarding management of greenhouse gases.

The Program provided support for two major U.S. programs of experimental research that directly addresses carbon cycle issues: the Ameriflux national network of CO₂ flux towers that measure net ecosystem carbon exchange, and the Free Air Carbon Dioxide Exposure (FACE) facility in Rhinelander, WI. The FACE facility emphasizing ecosystem-level responses to the interactive effects of elevated CO₂ and ozone on northern hardwood tree species with results that could not be predicted from models.

The Program collaborated with the Forest Inventory and Forest Health Monitoring programs, and with USGS and the NPS, to develop and implement a state-of-the-art monitoring system for forest health and water quality in the Delaware River Basin.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4455

Problem 2 Global Change Research. (Continued)

Publications

Research Unit Birdsey, Richard; Alig, Ralph; Adams, Darius. 2000. Chapter 8. Mitigation activities in the forest sector to reduce emissions and enhance sinks of greenhouse gases. The impact of climate change on America's forests: a technical document supporting the 2000 USDA Forest Service RPA assessment. Gen. Tech. Rep. RMRS-GTR-59. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 112-131.

Pan, Y.; Birdsey, R.A.; Hom, J.; Aber, J. 2000. Effect of increasing N deposition on forest carbon storage and N leaching loss in forested watersheds: the FIA based simulations using a forest ecosystem model. In: Ecology: achievement and challenge, a joint meeting of the British Ecological Society and the Ecological Society of America. 2000 April 10-13; Orlando, FL. [Place of publication unknown]: [Publisher unknown]: 35. Abstract.

Pan, Y.; Hom, J.; Jenkins, J.; Grove, J.M.; Aber, J. 1999. Predicting water yield and N leaching losses in forests and evaluating impact of increased N deposition in the Chesapeake Basin. In: The Ecological Society of America 84th annual Meeting. 1999 August 8-12; Spokane, WA. [Place of publication unknown]: [Publisher name unknown]: 111. Abstract.

Prasad, Anantha M.; Iverson, Louis R. 2000. Predictive vegetation mapping using a custom built model-chooser: comparison of regression tree analysis and multivariate adaptive regression splines. In: 4th international conference on integrating GIS environmental modeling (GIS/EM4): problems, prospects and research needs; 2000 September 2-8; Banff, AB. Boulder, CO: University of Colorado: Online publication. Available at: <http://www.colorado.edu/research/cires/banff/upload/159/index.html>

Schweik, Charles M.; Grove, J. Morgan. 2001. Fostering open-source research via a world wide web system. In: Available: <http://www.opensource.org>. Abstract.

Cooperative Bachelet, Dominique; Neilson, Ronald P. 2000. Chapter 2. Biome redistribution under climate change. In: The impact of climate change on America's forests: a technical document supporting the 2000 USDA Forest Service RPA assessment. Gen. Tech. Rep. RMRS-GTR-59. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 18-44.

Dickson, R.E.; Lewin, K.F.; Isebrands, J.G.; Coleman, M.D.; Heilman, W.E.; Riemenschneider, D.E. 2000. Forest atmosphere carbon transfer and storage (FACTS-II) the aspen free-air CO₂ and O₃ enrichment (FACE) project: an overview. Gen. Tech. Rep. NC-214. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 68.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4455

- Cooperative** **Heath, Linda S.; Smith, James E. 2000. Chapter 6. Soil carbon accounting and assumptions for forestry and forest-related land use change. In: The impact of climate change on America's forests: a technical document supporting the 2000 USDA Forest Service RPA assessment. Gen. Tech. Rep. RMRS-GTR-59. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 89-101.**
- Heilman, W.E.; Zasada, J.C. 2000. Modeling the atmospheric dynamics within and above vegetation layers. In: Seventh symposium on systems analysis in forest resources. Gen. Tech. Rep. NC-205. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 261-267.**
- Hom, J.; Nowak, D.; Golub, D.; Heisler, G.; Grimmond, S.; Offerle, B. 2001. Studies on carbon flux in urban forests at the Baltimore ecosystem study LTER. In: Abstracts of scientific papers and posters presented at the Global Change Open Science Conference, Challenges of a changing earth; 2001 July 10-13; Amsterdam, The Netherlands. [Place of Publication unknown]: {Publisher name unknown}: [Page number unknown]. Abstract.**
- Host, George E.; Isebrands, J. G. 1997. Epic-ecophys: A linkage of empirical and process models for simulating poplar plantation growth. In: Empirical and process-based models for forest tree and stand growth simulation; 1997 September 21-27; Oeiras, Portugal. 419-429.**
- Jenkins, Jennifer C.; Birdsey, Richard A.; Pan, Yude. 2000. Biomass and NPP estimation for the mid-Atlantic region (USA) using plot-level forest inventory data. Ecological Applications. 11(4): 1174-1193.**
- Joyce, Linda A. 2000. Birdsey, R.A., tech. eds. The impact of climate change on America's forests: a technical document supporting the 2000 USDA Forest Service RPA assessment. Gen. Tech. Rep. RMRS-GTR-59. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 133.**
- Joyce, Linda A.; Birdsey, Richard A. 2000. Chapter 1. Overview: Assessing the impacts of climate change on U.S. forests. In: Joyce, Linda A.; Birdsey, Richard A., tech. eds. The impact of climate change on America's forests: a technical document, support the 2000 USDA Forest Service RPA assessment. Gen. Tech. Rep. RMRS-GTR-59. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 5-17.**
- Joyce, Linda A.; Nungesser, Martha. 2000. Chapter 3. Ecosystem productivity and the impact of climate change. In: Joyce, Linda A.; Birdsey, Richard A., tech. eds. The impact of climate change on America's forests: a technical document supporting the 2000 USDA Forest Service RPA assessment. Gen. Tech. Rep. RMRS-GTR-59. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 45-68.**
- Potter, Brian E. 2001. Passive frost-risk reduction for forest management in northern hardwoods. In: Seventh symposium on system analysis in forest resources. Gen. Tech. Rep. NC-205. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 236-240.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4455

- Cooperative** **Potter, Brian E.; Teclaw, Ronald M.; Zasada, John C. 2000. The impact of forest structure on near-ground temperatures during two years of contrasting temperature extremes. *Agricultural and Forest Meteorology*. 106: 331-336.**
- Smith, James. E.; Heath, Linda S. 2000. Chapter 7. Considerations for interpreting probabilistic estimates of uncertainty of forest carbon. In: *The impact of climate change on America's forests: a technical document supporting the 2000 USDA Forest Service RPA assessment*. Gen. Tech. Rep. RMRS-GTR -59. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 102-111.**
- Extramural** **Karnosky, David F. 2001. Impacts of air pollution and climate change of forest tree populations. In: *Forests and society: the role of research, sub-plenary sessions, vol. 1, XXI IUFRO World Congress 2000; 2000 August 7-12; Kuala Lumpur, Malaysia*. Kuala Lumpur, Malaysia: Malaysian XXI IUFRO World Congress Organizing Committee: 133-139.**
- Karnosky, David; Noormets, Asko; Sober, Anu; Percy, Kevin E.; Mankovska, Blanka; Sober, Jaak. 2001. Preliminary results from the FACTS 2 (Aspen FACE) experiment: Interactions of elevated CO₂ and O₃. In: *Carbon dioxide and vegetation: advanced international approaches for absorption of CO₂ and responses to CO₂ - the 13th global environment Tsukuba; 2001 March; Tsukuba, Japan*. CGER-1046-2001. Onogawa, Tsukuba, Ibaraki, Japan: Center for Global Environmental Research: 62-76.**
- Percy, Kevin E.; Karnosky, David F.; Innes, John L. 2000. Potential roles of global change in forest health during the 21st century. In: *Forests and society: the role of research, sub-plenary sessions, vol. 1, XXI IUFRO World Congress 2000; 2000 August 7-12; Kuala Lumpur, Malaysia*. Kuala Lumpur, Malaysia: Malaysian XXI IUFRO World Congress Organizing Committee: 147-163.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4501

Role of Forest Insect Biology and Biocontrol in Maintaining Forest Health
Shields, Kathleen, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Outputs		
			Research Unit	Extramural	Cooperative
1. Improve understanding of biology and ecology of native and exotic forest insects.	499	1.8	4	1	0
2. Develop biologically based technologies to manage forest insect pests.	425	1.2	6	4	0
3. Develop quantitative methods for pest risk assessment of insect pests.	173	1	0	0	1

NORTHEASTERN RESEARCH STATION
Research Unit NE-4501

Problem 1 **Improve understanding of biology and ecology of native and exotic forest insects.**

Publications

- Research** Keena, Melody A. 2000. *Anoplophora glabripennis* (Coleoptera: Cerambycidae) development on cut logs of four species of *Acer*. Poster presentation at the 2000 joint annual meeting, Societe d'entomologie du Quebec, Entomological Society of Canada, Entomological Society of America; 2000 December 3-6; Montreal, PQ. Poster.
- Shields, Kathleen S. 2000. Histology and ultrastructure of antennae of *Anoplophora glabripennis* (Coleoptera: Cerambycidae). Poster presentation at the 2000 joint annual meeting, Societe d'entomologie du Quebec, Entomological Society of Canada, Entomological Society of America; 2000 December 3-6; Montreal, PQ. Poster.
- Williams, David W.; Liebhold, Andrew M. 2000. Spatial synchrony of spruce budworm outbreaks in eastern North America. *Ecology*. 81(10): 2753-2766.
- Williams, David. 2001. Research on *Anoplophora glabripennis* in South Korea. Poster presentation at joint IUFRO Working Party Meeting; 2001 September 10-13; Aberdeen, Scotland. Poster.
- Cooperative** Liebhold, Andrew; Elkinton, Joseph; Williams, David; Muzika, Rose-Marie. 2000. What causes outbreaks of the gypsy moth in North America? *Population Ecology*. 42: 257-266.
- Extramural** Rosovsky, Judy. 2001. Gypsy moth management in Vermont focal areas. Burlington, VT: University of Vermont: 102p. M.S. thesis.
- Attainment** The spatial synchrony of outbreaks of the spruce budworm, *Choristoneura fumiferana*, was investigated over much of its outbreak range in eastern North America during the period 1945-1988. Spruce budworm outbreaks were determined to be synchronized spatially and the dynamics of the outbreaks appeared to be driven by the combined effects of a regional stochastic disturbance and the dispersal behavior of the species, which serve together to entrain its local populations across the region. Using two tests for direct density dependence and standard techniques of time series analysis, density dependence was identified in the defoliation time series. The rate of detection of direct density dependence decreased with increasing spatial scale. These results reinforce the importance of considering spatial scale when diagnosing population processes using time series of abundance for single species.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4501

Problem 2 **Develop biologically based technologies to manage forest insect pests.**

Publications

- Research** Lu, Wenhua; Montgomery, Michael E. 2001. Oviposition, development, and feeding of *Scymnus* (Neopullus) *sinuanodulus* (Coleoptera: Coccinellidae): a predator of *Adelges tsugae* (Homoptera: Adelgidae). *Annals of the Entomological Society of America*. 94(1): 64-70.
- Montgomery, Michael E. 1999. Woolly adelgids in the Southern Appalachians: why they are harmful and prospects for control. In: *Proceedings of the Southern Appalachian biological control initiative workshop; 1996 September 26-27; Asheville, NC. FHTET-98-14. Morgantown, WV: U.S. Department of Agriculture, Forest Service, Forest Health Technology Enterprise Team: 45-57.*
- Montgomery, Michael E. 2001. Hemlock woolly adelgid biocontrol with lady beetles from China. In: *Proceedings of the 2000 annual gypsy moth review; 2000 October 30-November 2; Norfolk, VA. Norfolk, VA: Virginia Department of Agriculture: 240-243.*
- Montgomery, Michael; Havill, Nathan. 2001. Field evaluation of a Chinese lady beetle for biological control of the hemlock woolly adelgid. Poster presentation: 2000 joint annual meeting Societe d'entomologie du Quebec, Entomological Society of Canada, Entomological Society of America; 2000 December 3-6; Montreal, Quebec, Canada. Poster.
- Shields, Kathleen S. 2001. Use of remote sensing and GIS to measure decline of eastern hemlock. In: *Proceedings of the 2000 annual gypsy moth review; 2000 October 30-November 2; Norfolk, VA. Norfolk, VA: Virginia Department of Agriculture: 238-239.*
- Withers, T.M.; Keena, M.A. 2001. *Lymantria monacha* (nun moth) and *L. dispar* (gypsy moth) survival and development on improved *Pinus radiata*. *New Zealand Journal of Forestry Science*. 31(1): 66-77.
- Extramural** ODell, T. 2000. Arthropod parasites and predators of the gypsy moth, *Lymantria dispar* (L.) (Lepidoptera: Lymantriidae). In: Coulson, J.R.; Vail, P.V.; Dix, M.E.; Nordlund, D.A.; Kauffman, W.C., eds. *110 years of biological control research and development in the United States Department of Agriculture: 1883-1993. Beltsville, MD: U.S. Department of Agriculture, Agriculture Research Service: 416-424.*
- Solter, L.; Keena, M.; Cate, J.; McManus, M.; Higgs, M., Hanks, L. 2001. Infectivity of Rhabditoid nematodes to the Asian longhorn beetle. *Environmental Horizons* 2001; 2001 March 24; University of Illinois, Champaign-Urbana, IL. Poster.
- Solter, Leellen F.; Keena, Melody; Cate, James R.; McManus, Michael L.; Hanks, Lawrence M. 2001. Infectivity of four species of nematodes (Rhabditoidea: *Steinernematidae*, *Heterorhabditidae*) to the Asian longhorn beetle, *Anoplophora glabripennis* (Motschulsky) (Coleoptera: Cerambycidae). *Biocontrol Science and Technology*. 11: 547-552.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4455

- Extramural** Zolubas, P.; Gedminas, A.; Shields, K. 2001. Gypsy moth parasitoids in the declining outbreak in Lithuania. *Journal of Applied Entomology*. 125: 229-234.
- Attainment** Research on biological control of Asian gypsy moth, nun moth, hemlock woolly adelgid, and Asian longhorned beetle has resulted in significant progress in development of biologically based technologies to manage these non-native forest insect pests. A three-year study was completed in Lithuania on the impacts of parasitoids on declining outbreaks of Asian gypsy moth. This study provided a better understanding of the conditions leading to an outbreak, and the value of parasitoids in managing gypsy moth populations. Laboratory trials within quarantine provided information on the survival and development of nun moth on *Pinus radiata* and *Picea glauca* and Asian gypsy moth on *P. radiata* and *Quercus velutina*. *P. radiata* was determined to be an acceptable and suitable host for nun moth, and was predicted to be under a low to moderate threat from gypsy moth. Oviposition, development, and feeding of *Scymnus sinuanodulus*, a potential biological control of hemlock woolly adelgid, were described. *S. sinuanodulus* lady beetles were collected from native hemlocks in China and were propagated and evaluated within quarantine in the U.S. It was determined that adult beetles fed on all stages of adelgid, but feeding rate and feeding preference may vary seasonally. Although the fecundity of *S. sinuanodulus* is relatively low, its behavior of laying single eggs suggests that it can reproduce well even at low prey density. Its univoltinism and multi-year life span may enhance survival of both adults and larvae in the field.
- Four species of entomopathogenic nematodes were tested for their ability to kill and reproduce in larvae of the Asian longhorned beetle. Preliminary studies established that two species, *Heterohabditis marelatus* and *Steinernema carpocapsae*, produced high mortality rates and were able to reproduce in Asian longhorned beetle.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4501

Problem 3 **Develop quantitative methods for pest risk assessment of insect pests.**

Publications

Cooperative **Kliejunas, John T.; Tkacz, Borys M.; Burdsall, Jr., Harold H.; DeNitto, Gregg A.; Eglitis, Andris; Haugen, Dennis A. 2001. Pest risk assessment of the importation into the United States of unprocessed Eucalyptus logs and chips from South America. In: Gen. Tech. Rep. FPL-GTR-124. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory: 134.**

Attainment **Developed pest risk assessments for leafcutting ants, Eucalyptus weevil, flea of the tifa leaf, and purple moth being introduced into the US as a consequence of importing unprocessed Eucalyptus logs and chips from South America. These insect pests were evaluated for likelihood of introduction, including pest with host-commodity at origin potential, entry potential, colonization potential, and spread potential. The consequences of introduction were determined based on economic damage potential, environmental damage, and social and political considerations. A pest risk potential was assigned to each insect or group of closely related insects. The pest risk potential of leafcutting ants was determined to be low (likelihood of introduction = low; consequences of introduction = high). Pest risk potential of Eucalyptus weevil was determined to be moderate (likelihood of introduction = moderate; consequences of introduction = moderate). Pest risk potential of flea of tifa leaf was determined to be low (likelihood of introduction = low; consequences of introduction = moderate). Pest risk potential of purple moth was determined to be high (likelihood of introduction = high; consequences of introduction = moderate).**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4502

Pathology and Microbial Control of Insects That Impact the Health of Eastern Forests
McManus, Michael L., Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding	Current Staffing	Research Unit	Research Outputs	
				Extramural	Cooperative
	(\$1,000)	(Scientist years)			
1. Develop the technology to optimize performance of Bt against native and exotic defoliating insects.	132	.8	1	0	0
2. Optimize production and performance of GYPCHEK against the gypsy moth and understand NPV epizootiology.	614	1.2	3	0	0
3. Accelerate the use of entomopathogens against invasive and newly-established forest pests.	96	1	4	1	0
4. Determine the effect of microbial pesticides and non-indigenous pathogens against non-target organisms.	0	0	0	1	0

NORTHEASTERN RESEARCH STATION
Research Unit NE-4502

Problem 1 **Develop the technology to optimize performance of Bt against native and exotic defoliating insects.**

Publications

Research **Dubois, N.R.; McManus, M.L.; Huntley, P.J.; Newman, D. 2001. Implementation of a program to optimize the use of *Bacillus thuringiensis* against the browntail moth (*Euproctis chrysorrhoea*). In: Liebhold, A.J.; McManus, M.L.; Otvos, I.S.; Fosbroke, S.L.C., eds. Proceedings: integrated management and dynamics of forest defoliating insects; 1999 August 15-19; Victoria, BC. Gen. Tech. Rep. NE-277. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 37-44.**

Attainment **Research is continuing both in the USA and in China to determine the feasibility of using *Bacillus thuringiensis* (Bt) products as microbial pesticides against the Asian Longhorned Beetle (ALB), either as foliar sprays or as toxins incorporated into ALB host plants. Bt has been used successfully against beetles in the cerambycid subfamily and is a safe alternative to chemical pesticides in urban and suburban areas. Initial testing has been completed in quarantine to determine the efficacy of individual Bt Cry toxins against ALB by using a voltage clamp apparatus that measures changes in current flow across the insect's gut membrane to determine susceptibility. Voltage clamp technology, previously shown to be effective in measuring lepidopteran gut responses to Bt, was successfully modified to allow testing of fragile ALB gut tissue. Positive responses were seen for several toxins tested. In addition, an ALB brush-border-membrane-vesicle assay was developed through a cooperative agreement with Ohio State University scientists. This assay allows for the quick screening of large number of Bt toxins that may be effective against ALB and has revealed a least one (Cry 1B) that warrants further testing and study. A collaborative study with the Chinese Academy of Forestry to assay commercial Bt products was completed. Results were equivocal and will be repeated in FY-02 under a cooperative agreement with Chinese scientists.**

Results of the Bt work to date have been communicated through presentations at scientific meetings and workshops and through publications.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4502

Problem 2 Optimize production and performance of GYPCHEK against the gypsy moth and understand NPV epizootiology.

Publications

Research D'Amico, Vincent; Elkington, Joseph S.; Podgwaite, John D. 2001. Clumping explains nonlinear transmission of LDNPV in the gypsy moth. In: Proceedings of the 2000 annual gypsy moth review; 2000 October 30-November 2; Norfolk, VA. Norfolk, VA: Virginia Department of Agriculture: 160. Abstract.

Podgwaite, John D.; Slavicek, James M. 2000. Development of "GypchekTM", a gypsy moth pathogen. In: Coulson, J.R.; Vali, P.V.; Dix, M.E.; Nordlund, D.A.; Kauffman, W.C., eds. 110 years of biological control research and development in the United States Department of Agriculture: 1883-1993. Washington, DC: U.S. Department of Agriculture, Agricultural Research Service: 424-427.

Webb, R. E.; Shapiro, M.; Thorpe, K.W.; Peiffer, R.A.; Fuester, R.W.; Podgwaite, J.D. 2001. Potentiation by a granulosis virus of Gypchek, the gypsy moth (Lepidoptera: Lymantriidae) nuclear polyhedrosis virus product. Journal of Entomological Science. 36(2): 169-176.

Attainment Gypchek, the gypsy moth specific viral pesticide, continues to be produced by project personnel in cooperation with the APHIS Methods Development Center on Cape Cod, MA. In FY-2001, over 2000 acres of environmentally sensitive habitats in Michigan, Ohio, West Virginia and Maryland that were infested with gypsy moth were treated in conjunction with state and federal cooperative suppression and eradication programs. Collaborative laboratory and field studies with ARS, University, and RWU-4509 scientists were initiated to determine the efficacy of a gypsy moth NPV (LdNPV-203) produced using three different in vitro production protocols. The long-term goal of this work is to select an LdNPV isolate using a cell culture system that is at least as efficacious as the viral genotypes in the current in vivo Gypchek product and that is cleaner and less expensive to produce. In laboratory bioassays, LC50 values for LdNPV-203 produced by all three production methods were comparable to a current lot of Gypchek produced in vivo. A 'bugs-in-bags' experiment conducted on the Cedar Swamp wildlife area in Delaware was conducted to determine the efficacy of the three production lots of LdNPV-203, that were formulated w/and w/o Gypchek Carrier 038. Formulations were exposed for 1-3 days on branch tips that were subsequently infested with gypsy moth larvae.

Results indicated that LdNPV-203 produced by all three methods was at least as persistent and efficacious as Gypchek and that LdNPV-203 produced by one method was marginally better. Results were essential to planning and conducting a ground hydraulic test of an in vitro product in FY-2002 and an aerial test in FY-2003. Data from several LdNPV epizootiological experiments conducted over a three year period currently are being analyzed in an effort to construct models of LdNPV transmission in early instar larvae. These models will be useful in predicting population trends and will offer resource managers information useful in the development of gypsy moth control programs.

Results from the above mentioned studies have been communicated either through presentations before scientific societies or through published manuscripts.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4502

Problem 3 Accelerate the use of entomopathogens against invasive and newly-established forest pests.

Publications

Research McManus, M.L. 2001. Perspectives on the gypsy moth here and abroad. In: Proceedings of the 2000 annual gypsy moth review; 2000 October 30-November 2; Norfolk, VA. Norfolk, VA: Virginia Department of Agriculture: 37-48.

Novotny, Julius; Pilarska, Daniela; Maddox, Joseph; McManus, Michael. 2000. Studies of frequency of entomopathogens in populations of gypsy moth (*Lymantria dispar* L.) in Slovakia during a latency period. Acta Zoologica Bulgaria. 52(1): 45-49.

Pilarska, D.; Linde, A.; Goertz, D.; McManus, M.; Solter, L.; Bochev, N. 2001. First report on the distribution of microsporidian infections of browntail moth (*Euproctis chrysorrhoea* L.) populations in Bulgaria. Journal of Pest Science. 74: 37-39.

Pilarska, D.; McManus, M.; Hajek, A.E.; Herrard, F.; Vega, F.E.; Pilarska, P. 2000. Introduction of the entomopathogenic fungus *Entomophaga maimaiga* Hum., Shim. & Sop. (Zygomycetes: Entomophthorales) to a *Lymantria dispar* (L.) (Lepidoptera: Lymantriidae) population in Bulgaria. Journal of Pest Science. 73(5): 123-126.

Extramural Turcani, M.; Novotny, M.; Zubrick, M.; McManus, M.; Pilarska, D.; Maddox, J. 2001. The role of biotic factors in gypsy moth population dynamics in Slovakia: present knowledge. In: Liebhold, A.M.; McManus, M.L.; Otvos, I.S.; Fosbroke, S.L.C., eds. Proceedings: integrated management and dynamics of forest defoliating insects; 1999 August 15-19; Victoria, BC. Gen. Tech. Rep. NE-277. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 152-167.

Attainment Four species of entomopathogenic nematodes were tested for their ability to kill and reproduce in larvae of the Asian longhorned beetle (ALB). ALB larvae were permissive to all four species however two species, *Steinernema carpocapsae* and *Heterorhabditis marelatus* caused higher mortality and produced more juveniles in their host larvae. Preliminary studies indicate that *H. marelatus* juveniles were capable of locating and killing ALB larvae within their galleries in cut logs. Further studies are being conducted to evaluate their feasibility as a biocontrol agent against the ALB.

Microsporidia belonging to two different genera were recovered from larval populations of the browntail moth in Bulgaria and are widely distributed. Further studies on the taxonomy of these isolates are being conducted along with a determination of their host specificity against other forest Lepidoptera. The ultimate goal of these studies is to determine the feasibility of introducing microsporidia for biocontrol of the browntail moth in New England.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4502

Problem M1 Determine the effect of microbial pesticides and non-indigenous pathogens against non-target organisms.

Publications

Research Liebhold, A.M.; McManus, M.L.; Otvos, I.S.; Fosbroke, S.L.C., eds. 2001. Proceedings, Integrated management and dynamics of forest defoliating insects. 1999 August 15-19; Victoria, BC. Gen. Tech. Rep. NE-277. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station; 167:

Extramural Solter, Leellen F.; Pilarska, Daniela K.; Vossbrinck, Charles F. 2000. Host specificity of microsporidia pathogens to forest Lepidoptera. *Biological Control*. 19: 48-56.

Attainment The host specificity of microsporidia pathogens of Lepidoptera was studied in Bulgaria where native populations of the gypsy moth occur. Three species of microsporidia pathogenic to European gypsy moths were recovered from four different localities, along with 11 isolates from 1494 individual lepidoptera hosts. Feed-back experiments confirm that laboratory determination of the host specificity of the gypsy moth isolates are accurate and possibly conservative. None of the gypsy moth isolates infected other Lepidoptera hosts; molecular analyses of the isolates from other lepidoptera larvae indicate that they are distinct from the genera reported from the gypsy moth.

NORTHEASTERN RESEARCH STATION

Research Unit NE-4505

Disturbance of Eastern Forest Ecosystems by Stressor/Host/Pathogen Interactions
Smith, Kevin T, Project Leader**FY 2001 Research Attainments**
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Outputs		
			Research Unit	Extramural	Cooperative
1. Relationship of stressor/host/pathogen and site interactions to forest maturation, disturbance, and gap formation is poorly understood.	422	1.9	2	2	1
2. Too few dependable early indicators of forest tree vulnerability to disturbance from stressor/host/pathogen interactions.	497	2.3	7	1	0
3. Tools are inadequate to predict, prevent, and mitigate disturbances that threaten forest sustainability and management objectives.	193	.8	1	0	0

NORTHEASTERN RESEARCH STATION
Research Unit NE-4505

Problem 1 Relationship of stressor/host/pathogen and site interactions to forest maturation, disturbance, and gap formation is poorly understood.

Publications

Research Marcais, B.; Wargo, P.M. 2000. Impact of liming on the abundance and vigor of *Armillaria rhizomorphs* in Allegheny hardwoods stands. *Canadian Journal of Forest Research*. 30: 1847-1857.

Wargo, Philip M.; Carey, A.C. 2001. Effects of metals and pH on in vitro growth of *Armillaria ostoyae* and other root and butt rot fungi of red spruce. *Forest Pathology*. 31: 5-24.

Cooperative Sutherland, Elaine Kennedy; Smith, Kevin T. 2000. Resistance is not futile: The response of hardwoods to fire-caused wounding. In: Yaussy, Daniel A., comp. *Proceedings: workshop on fire, people, and the central hardwoods landscape; 2000 March 12-14; Richmond, KY*. Gen Tech. Rep. NE-274. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 111-115.

Extramural Hughes, Monica, Weir, Alex; Worrall, Jim; Wargo, Philip. 2001. Abundance of *Armillaria* spp. and *Megacollybia platyphylla* in *Quercus rubra* stumps over 17 year period. 10th IUFRO root and butt rot conference working group #7.02.01; 2001 September 16-22; Quebec City, PQ. Poster.

Kuz'michev, Evgeny P.; Sokolova, Ella S.; Kulikova, Elena G. 2001. Common fungal diseases of Russian forests. In: Gen. Tech. Rep. NE-279. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 137.

Attainment The Neversink Valley in the upper Delaware River Basin of New York continues to be investigated to determine the relationship of acidic deposition, soil chemistry, and tree growth and stress. A second series of study areas from ridge top to lower slope provided foliage for assays of current stress using amino acids and polyamines as biochemical indicators. Long-term changes in tree growth and in essential calcium and magnesium in forest soils are being investigated using dendrochronological and dendrochemical techniques.

Armillaria root disease is caused by several species of fungi and seriously affects oak and other tree species. DNA analysis indicates that several to many genetic individuals of a given species of *Armillaria* exist in a single forest stand. Mortality in six oak stands in Pennsylvania was related to the oak species and to the spatial extent and genetic identity of the *Armillaria* pathogen.

Research on tree injury from the regional ice storm of 1998 reveals a complex set of responses. Survival and rapid recovery depended on the proximity of intact branches to branch breaks and stem snaps. The biochemical marker putrescine indicated less stress in trees with low levels of injury (loss of less than one-half of the crown) than in uninjured trees, presumably due to reduced competition for energy and essential elements both among and within trees. The ability of trees to compartmentalize the storm injury and resist the loss of healthy wood to infection was compromised by the presence of major wounds made earlier in the life of the tree.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4505

Attainment **Forest trees and wildlife depend directly or indirectly on soil characteristics determined by bacteria and fungi. Microbiological research on forest soils reveals differences in microbial populations based on soil horizon and season. These differences may be due to variable soil moisture.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4505

Problem 2 Too few dependable early indicators of forest tree vulnerability to disturbance from stressor/host/pathogen interactions.

Publications

Research Minocha, Rakesh. 2000. Stress test for trees. *Northern Woodlands* (Autumn): 25.

Shortle, Walter C. 2001. CODIT. In: Maloy, Otis, C.; Murray, Timothy D., eds. *Encyclopedia of plant pathology*. New York, NY: John Wiley & Sons: 233-234.

Shortle, Walter C. 2001. Shigometer. In: Maloy, Otis, C.; Murray, Timothy D., eds. *Encyclopedia of plant pathology*. New York, NY: John Wiley & Sons: 902-903.

Smith, Kevin T. 2001. Bavendamn reaction. In: Maloy, Otis, C.; Murray, Timothy D., eds. *Encyclopedia of plant pathology*. New York, NY: John Wiley & Sons: 120-121.

Smith, Kevin T. 2001. Decay indicator. In: Maloy, Otis, C.; Murray, Timothy D., eds. *Encyclopedia of plant pathology*. New York, NY: John Wiley & Sons: 293.

Smith, Kevin T. 2001. Zone lines. In: Maloy, Otis, C.; Murray, Timothy D., eds. *Encyclopedia of plant pathology*. New York, NY: John Wiley & Sons: 1217-1218.

Smith, Kevin T.; Shortle, Walter C. 2001. Conservation of element concentration in xylem sap of red spruce. *Trees*. 15: 148-153.

Extramural Bhatnagar, Pratiksha; Glasheen, Bernadette M.; Bains, Suneet K.; Long, Stephanie L.; Minocha, Rakesh; Walter, Christian. 2001. Transgenic manipulation of the metabolism of polyamines in poplar cells. *Plant Physiology*. 125: 2139-2153.

Attainment Lime applications improved stands of mature sugar maple in north-central Pennsylvania. Improvements were measured as crown appearance, cambial electrical resistance, width of annual rings, and increased amounts of essential calcium and magnesium in soil and foliage. Trees in poor condition benefited the most from liming as indicated by cambial electrical resistance.

The polyamine putrescine has been validated as a general stress marker through the biochemical testing of more than 1000 conifer and hardwood trees across northern New England and New York. The amino acid arginine showed promise as a marker of nitrogen saturation due to atmospheric deposition in northeastern forests.

Wood chemistry as a record of past environmental change continued to be developed for red spruce in northern New York and New England. The challenge has been to differentiate the effects of internal biological processes from changes in the chemical environment of the atmosphere and in forest soil. The internal processes are complicated by changes due to tree ageing and wood maturity as well as changes due to injury and infection. Findings from red spruce are being compared to sugar maple and yellow birch from the upper Delaware River Basin, European spruce and Siberian fir from Russia, and southern beech from Tierra del Fuego.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4505

Attainment **Three years after the regional ice storm of 1998, the loss of up to one-half of the live crown had little effect on tree ring-width. Defect due to branch injury rarely extended into the main stem. Serious loss of growth and wood quality did occur in trees with previous injuries to the base of the stem, such as those caused by logging and road building.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4505

Problem 3 Tools are inadequate to predict, prevent, and mitigate disturbances that threaten forest sustainability and management objectives.

Publications

Research Smith, Kevin T.; Shortle, Walter C.; Dudzik, Kenneth R. 2001. Patterns of storm injury and tree response. NA-TP-02-01. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 4.

Attainment The effects of the regional ice storm injury on tree growth and wood quality were presented in a series of formats including lay publications and workshops in cooperation with the National Forest System, state foresters, and university cooperative extension.

Indicators of tree vitality were used to assess the beneficial effects of liming stands of mature sugar maple in north-central Pennsylvania. Useful indicators included amino acids and polyamines in the foliage, starch and soluble sugars in the roots, and cambial electrical resistance of the main stem. Further tests will apply these indicators along gradients of stand health and essential element availability in the soil.

Project scientists contributed to the Local Impact Assessment of the New England Regional Assessment of the US Global Change Research Program, held in Durham, New Hampshire. The forum provided the basis for a concise and reader-friendly explanation of global climate change and its impact on local forest and water resources.

Terminology was developed to better describe and compare fire scars and evaluate the effects of wildfire and prescribed fire on tree growth, survival, and wood quality.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4509

Development of Biologically Based Controls for Insect Pests and Diseases
Slavicek, James M, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Outputs		
			Research Unit	Extramural	Cooperative
1. Fundamental development of biological agents and biorational approaches for insect control.	728	3	6	0	0
2. Develop biological and biorational approaches for control of tree diseases.	525	2	5	0	0
3. Use of biotechnology to generate solutions to problems supporting current research.	0	0	0	0	0

NORTHEASTERN RESEARCH STATION
Research Unit NE-4509

Problem 1 **Fundamental development of biological agents and biorational approaches for insect control.**

Publications

- Research** Popham, Holly J.R.; Bischoff, David S.; Slavicek, James M. 2001. Both *Lymantria dispar* nucleopolyhedrovirus Enhancin genes contribute to viral potency. *Journal of Virology*. 75(18): 8639-8648.
- Popham, Holly J.R.; Slavicek, J.M. 2001. Analysis of the expression, localization and function of the LdMNPV enhancing proteins 1 and 2. In: Society for Invertebrate Pathology 34th annual meeting , the Israeli-Dutch meeting, program and abstracts; 2001 August 25-30; Noordwijkerhout, The Netherlands. [Place of publication unknown]: [Publisher name unknown]: ABS70. Abstract.
- Slavicek, J.M.; Hayes-Plazolles, N.; Kelly, M.E. 2001. A mutation in the LdMNPV p24 gene causes synthesis of abnormal polyhedra. In: Society for Invertebrate Pathology 34th annual meeting, the Israeli-Dutch meeting, program and abstracts; 2001 August 25-30; Noordwijkerhout, The Netherlands. [Place of publication unknown]: [Publisher name unknown]: ABS69. Abstract.
- Slavicek, J.M.; Hayes-Plazolles, N.; Popham, H.J.R.; Bischoff, D.S. 2001. The budded virus of LDMNPV isolate 122B exhibits increased infectivity compared to the wild-type budded virus. In: American Society for Virology 20th annual meeting, scientific programs and abstracts; 2001 July 21-25; Madison, WI. [Place of publication unknown]: [Publisher name unknown]: 107. Abstract.
- Valaitis, Algimantas P. 2001. The Bt toxin receptor BTR-270 in gypsy moth is a highly acidic carbohydrate-rich molecule which binds Bt toxins with affinities that correlate with toxicity. In: Society for Invertebrate Pathology 34th annual meeting, the Israeli-Dutch meeting, program and abstracts; 2001 August 25-30; Noordwijkerhout, The Netherlands. [Place of publication unknown]: [Publisher name unknown]: ABS75. Abstract.
- Valaitis, Algimantas P.; Jenkins, Jeremy L.; Lee, Mi Kyong; Dean, Donald H.; Garner, Karen J. 2001. Isolation and partial characterization of gypsy moth BTR-270, an anionic brush border membrane glycoconjugate that binds *Bacillus thuringiensis* Cry1A toxins with high affinity. *Archives of Insect Biochemistry and Physiology*. 46: 186-200.
- Extramural** Sundaram, S.; Kim, S.J.; McQuattie, C.J.; Hiremath, S.T.; Podila, G.K. Isolation and characterization of a symbiosis-regulated ras from the ectomycorrhizal fungus *Laccaria bicolor*. *Molecular Plant-Microbe Interactions*. 14(5): 618-628.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4509

Attainment **Gypsy moth virus research:** The function of the enhancin 1 and enhancin 2 genes in the *Lymantria dispar* nucleopolyhedrovirus (LdMNPV) was investigated through bioassay of recombinant virus strains lacking these genes. Both enhancin genes were found to increase viral potency 10 fold individually and 12 fold collectively. LdMNPV isolate 122b exhibits stable polyhedra synthesis in cell culture production systems. The basis for this trait of isolate 122b was found to be a mutation in the DNA binding protein gene that caused the change of a single amino acid. ***Bacillus thuringiensis* research:** The gypsy moth *Bacillus thuringiensis* (Bt) toxin receptor BTR-270 is a highly acidic carbohydrate-rich peptide which binds Bt toxins with affinities that correlate with toxicity. The peptide and the carbohydrate moieties are both important for receptor function. Using BTR-270 as a probe we have demonstrated that the receptor can be used for screening toxins in vitro to identify new toxins that could have improved insecticidal activity. With further studies we aim to unravel the structural features that are critical in the toxin-receptor interaction to design more gypsy moth specific insecticidal toxins. **Ectomycorrhizal research:** Knowledge of the molecular basis of the establishment of ectomycorrhizal symbiosis with the host plant is essential for utilizing the mycorrhizae to their fullest potential. Extensive network of mycelium around roots enhances nutrient uptake by the host tree. A *L. bicolor* ras gene, potentially involved in fungal growth and proliferation, was cloned and characterized. Ultrastructural studies showed that the ras protein was localized near the fungal cell wall region. Preliminary genomics of ectomycorrhizal symbiosis identified several genes associated with symbiosis. Nearly 35% of them were homologues of known genes found in other systems.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4509

Problem 2 Develop biological and biorational approaches for control of tree diseases.

Publications

- Research** Carey, David W.; Kubisiak, Tom; Houston, Daniel B.; Houston, David R.; Koch, Jennifer R. 2001. RAPD analysis of post-disturbance *Fagus grandifolia* populations. In: IUFRO molecular biology of forest trees symposium: tree biotechnology in the new millennium; 2001 July 22-27; Stevenson, WA. [Place of publication unknown]: [Publisher name unknown]: 169. Abstract.
- Eshita, Steven M. 2001. 3-Hydroxybenzoic acid as an internal standard for the high-pressure liquid chromatography quantitation of salicylic acid in plants. *Analytical Biochemistry*. 289 99-102.
- Eshita, Steven M.; Kamalay, Joseph C.; Gingas, Vicki M.; Yaussy, Daniel A. 2000. Establishment and characterization of American elm cell suspension cultures. *Plant Cell, Tissue and Organ Culture*. 61: 245-249.
- Koch, Jennifer; Nakajima, Nobuyoshi; Izumi, Yasutni; Saji, Hikaru; David, Keith R. 2001. Analysis of signaling pathways involved in defense responses of hybrid poplar. In: IUFRO molecular biology of forest trees symposium: tree biotechnology in the new millennium; 2001 July 22-27; Stevenson, WA. [Place of publication unknown] [Publisher name unknown]: 156. Abstract.
- Rao, Mulpuri V.; Koch, Jennifer R.; Davis, Keith R. 2000. Ozone: a tool for probing programmed cell death in plants. *Plant Molecular Biology*. 44: 345-358.

Attainment Tree stress research: Studies with a "defense deficient" hybrid poplar clone have shown that this clone is insensitive to ethylene, a plant hormone involved in both development and defense responses. This clone is the first tree species to be identified as having deficiencies in any of the three defense signaling pathways (ethylene, salicylic acid, jasmonic acid) and will be invaluable to our continued efforts to understand the mechanisms utilized by trees to defend themselves against both biotic and abiotic threats. A novel HPLC method was developed for the quantitation of salicylic acid and other related aromatic secondary metabolites in plants using 3-hydroxybenzoic acid as an internal standard. Beech bark disease research: Using RAPD analysis a method was developed to identify clonally related trees within a stand. Root cuttings from resistant trees were harvested and successfully used to generate shoots in an effort to micropropagate resistant beech trees. As a first step toward performing controlled crosses, pollen from resistant trees was collected and demonstrated to be viable. Current studies are focused on optimizing pollen storage conditions to maintain viability and longevity. Dutch elm disease research: Cell suspension cultures of Dutch elm disease (DED)-tolerant and DED-susceptible American elm clones have been established and characterized as prerequisites for studies of elm cellular responses to fungus-derived elicitors and fungus-conditioned media. Cell growth, monitored by light scattering and media conductivity, indicated relatively low variances among replicates within a genotype and no significant differences in between-genotype contrasts. Culture growth was reproducible for different initiations and culture cells were stable and essentially homogeneous after five subculture passages.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4509

Problem 3 **Use of biotechnology to generate solutions to problems supporting current research.**

Publications

Attainment **No progress to report at this time.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4557

Disturbance Ecology and Management of Oak-Dominated Forests
Gottschalk, Kurt W., Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Outputs		
			Research Unit	Extramural	Cooperative
1. Vegetation dynamics in response to gypsy moth defoliation, other exotic organisms and disturbances.	493	1.2	0	1	0
2. Landscape-scale population dynamics of gypsy moth and its use to develop management decisions.	579	1	3	1	1
3. Silvicultural treatments for rehabilitating and regenerating oak forests.	327	1.5	0	3	1
4. Models and decision support tools that synthesize and integrate disturbance effects and dynamics.	292	1	1	0	0
M1. Maintain long-term studies of gypsy moth silvicultural practices and transfer technology to users.	147	.3	1	0	0

NORTHEASTERN RESEARCH STATION
Research Unit NE-4557

Problem 1 **Vegetation dynamics in response to gypsy moth defoliation, other exotic organisms, and disturbances.**

Publications

Cooperative Muzika, R.M.; Liebhold, A.M.; Twery, M.J. 2000. Dynamics of twolined chestnut borer *Agrilus bilineatus* as influenced by defoliation and selection thinning. *Agricultural and Forest Entomology*. 2: 283-289.

Extramural Muzika, R.M.; Liebhold, A.M. 2001. Effects of gypsy moth defoliation in oak-pine forests in the northeastern United States. In: Liebhold, A.M.; McManus, M.L.; Otvos, I.S.; Fosbroke, S.L.C., eds. *Proceedings: integrated management and dynamics of forest defoliating insects; 1999 August 15-19; Victoria, BC*. Gen. Tech. Rep. NE-277. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 117-123.

Attainment The twolined chestnut borer, *Agrilus bilineatus*, is a major mortality agent of stressed oak trees (*Quercus spp.*) The spatial and temporal variation in abundance of twolined chestnut borer adults during a gypsy moth, *Lymantria dispar*, outbreak was examined to determine the influence of both defoliation and thinning on twolined chestnut borer abundance. Most oak tree mortality occurred in the year preceding the peak year of twolined chestnut borer abundance and abundance of twolined chestnut borer was positively associated with defoliation and mortality in the previous year. Twolined chestnut borers were more frequently associated with poor or fair crown condition trees than trees with good crown condition and were more abundant on members of the red oak group than the white oak group.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4557

Problem 2	Landscape-scale population dynamics of gypsy moth and its use to develop management decisions.
Publications	
Research	<p>Buonaccorsi, John P.; Elkinton, Joseph S.; Evans, Scott R.; Liebhold, Andrew L. 2001. Measuring and testing for spatial synchrony. <i>Ecology</i>. 82(6): 1668-1679.</p> <p>Liebhold, A.M.; McManus, M.L.; Otvos, I.S.; Fosbroke, S.L.C., eds. 2001. Proceedings, Integrated management and dynamics of forest defoliating insects. 1999 August 15-19; Victoria, BC. Gen. Tech. Rep. NE-277. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station; 167:</p> <p>Liebhold, Andrew M.; Kamata, Naota. 2000. Are population cycles and spatial synchrony a universal characteristic of forest insect populations? <i>Population Ecology</i>. 42: 205-209.</p> <p>Williams, David W.; Liebhold, Andrew M. 2000. Spatial synchrony of spruce budworm outbreaks in eastern North America. <i>Ecology</i>. 81(10): 2753-2766.</p>
Cooperative	Liebhold, Andrew; Elkinton, Joseph; Williams, David; Muzika, Rose-Marie. 2000. What causes outbreaks of the gypsy moth in North America? <i>Population Ecology</i> . 42: 257-266.
Extramural	Davidson, Christopher B.; Gottschalk, Kurt W.; Johnson, James E. 2001. European gypsy moth (<i>Lymantria dispar</i> L.) outbreaks: a review of the literature. Gen. Tech. Rep. NE-278. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 15.
Attainment	<p>Spatial synchrony of spruce budworm, <i>Choristoneura fumiferana</i>, outbreaks during the period 1945-1988 decreased with distance between local populations and approached zero near 2000 km. A pattern of geographically distinct blocks of clusters oriented along an east-west axis was revealed with cluster analysis. Spruce budworm outbreaks were synchronized by a combination of a spatially autocorrelated Moran effect and a high dispersal rate. In a seminal paper, the statistical basis for measuring spatial synchrony was reviewed and techniques recommended. Alternative approaches to testing for no synchrony and their limitations are presented including tests based on residuals, adjusted degrees of freedom tests, and bootstrap procedures. Recommended tests are based on residuals in a model-based setting. Some of the difficulties of finding model-free approaches are discussed and some methods based on confidence intervals are suggested for future study. A review of population dynamics of forest insects shows two types of behavior seem to be common in forest insect populations: periodic oscillations ("population cycles") and spatial synchrony (synchronous fluctuations over large geographic areas). A greater emphasis on using statistical methods for detecting periodic behavior and for identifying other types of population behavior is needed. Spatial synchrony appears to be even more ubiquitous in forest insect populations. Dispersal and regional stochasticity ("Moran effect") have been shown to be capable of producing synchrony, but more research is needed to determine the relative contributions of these processes to synchrony observed in natural populations.</p>

NORTHEASTERN RESEARCH STATION
Research Unit NE-4557

Attainment **Tree mortality resulting from gypsy moth outbreaks has been reviewed via a regional perspective. Mortality varies by tree species, by intensity and duration of defoliation, and by crown class.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4557

Problem 3 **Silvicultural treatments for rehabilitating and regenerating oak forests.**

Publications

- Research** Rebeck, Joanne; Gottschalk, Kurt W.; Scherzer, Amy J. 2001. How differently do seedlings of *Quercus alba*, *Q. prinus* and *Q. rubra* respond to low light intensities created by shading? In: Keeping all the part: preserving, restoring & sustaining complex ecosystems, Ecological Society of America; 86th annual meeting, 2001 August 5-10; Madison, WI. [Washington, DC]: [Ecological Society of America]: 184. Abstract.
- Cooperative** Miller, Gary W.; Baumgras, John E. 2001. Silvicultural opportunities for commercial utilization of small trees in Appalachian hardwood stands. In: Forest Products Society 55th annual meeting; 2001 June 24-27; Baltimore, MD. Madison, WI: Forest Products Society: 26. Abstract.
- Miller, Gary W.; Kochenderfer, James N.; Knibbs, James; Baumgras, John E. 2001. Vegetative conditions and management options in even-age stands on the Monongahela National Forest. In: Barras, Stan J., ed. Proceedings: national silvicultural workshop; 1999 October 5-7; Kalispell, MT. RMRS-P-19. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 40-47.
- Extramural** Duguay, Jeffrey P.; Wood, Petra Bohall; Miller, Gary W. 2000. Effects of timber harvests on invertebrate biomass and avian nest success. Wildlife Society Bulletin. 28(4): 1123-1131.
- Kochenderfer, Jeffrey P.; Zedaker, Shepard M.; Johnson, James E.; Smith, David W.; Miller, Gary W. 2001. Herbicide hardwood crop tree release in central West Virginia. Northern Journal of Applied Forestry. 18(2): 46-54.
- Williams, Ray R. 2000. A study of northern red oak (*Quercus rubra* L.) regeneration in central Vermont: an examination of herbivory and interspecific competition. Burlington, VT: University of Vermont. 79p. M.S. thesis.
- Attainment** A comprehensive survey of even-aged stands that regenerated between 1964 and 1990 on the Monongahela National Forest was initiated. Preliminary results indicate that clearcutting was successful in regenerating these young stands with a variety of woody and herbaceous plant species. The same tree species are present in the young stands that were present in the previous stand but with somewhat different proportions. Early cleanings using crop-tree management techniques and control of wild grapevines (*Vitis* sp.) are recommended to enhance the development of desirable tree species that meet specific silvicultural treatments at the stand level, thus facilitating control of vegetative conditions at larger scales for a variety of management objectives.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4557

Attainment Chemical crop tree release treatments were applied to young hardwood stands at three sites in West Virginia to evaluate the effectiveness of 3 herbicides in 5 formulations. The stands were dominated by black cherry (*Prunus serotina*) crop trees with American beech (*Fagus grandifolia*) as the major competitor that was treated to release the crop trees. After 12 months, all three herbicides applied using hack-and-squirt formulations provided almost complete control (99+%) of American beech. Imazapyr treatments adversely affected several crop trees and are not recommended for hardwood crop tree release. Glyphosate caused some crop tree damage but is recommended when suggested guidelines are followed. Triclopyr caused no crop tree damage and is recommended for crop tree release. The costs of the injection treatments varied from \$0.84 to 1.04 per ft² of basal area and are an effective way to increase the future value of Appalachian hardwood stands.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4557

Problem 4 **Models and decision support tools that synthesize and integrate disturbance effects and dynamics.**

Publications

Research **Colbert, J.J.; Fekedulegn, Desta. 2001. Effects of gypsy moth defoliation on tree growth - preliminary models for effects of cumulative defoliation on individual host tree radial increment. In: Liebhold, A.M.; McManus, M.L.; Otvos, I.S.; Fosbroke, S.L.C. eds. Proceedings: integrated management and dynamics of forest defoliating insects; 1999 August 15-19; Victoria, BC. Gen. Tech. Rep. NE-277. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 16-30.**

Attainment **Two hundred and one stands in the Ridge and Valley physiographic province of central Pennsylvania were followed from 1978 to 1985 and approximately one-third of these stands were followed until 1995. Individual trees on three 0.1-acre plots per stand were visited each year. These stands experienced two major defoliation episodes by the gypsy moth (*Lymantria dispar*), first from 1981 to 1982 and again from 1986 to 1987; some trees and stands also experienced significant defoliation in the early 1990's. In 1995, increment core samples were collected from plot trees based on a matrix of species, stand defoliation history, and crown class (dominance). Only core samples from the red oak and white oak (*Quercus* spp.) species groups were considered. The relationship between the sample population and the earlier classification of the forested area where the research sites are located were examined. Results indicated that using these data, models can be developed across the site classification scheme. The appropriateness of developing a single model from both species groups was considered. Finally, a cumulative effects model with data organized by severity of defoliation to individual trees over three years (current and the past two years' defoliation) was considered. Results provide reasonable individual tree growth effects of the species under consideration. In a forest model that uses individual tree lists to simulate forest stands, these growth effects models can be linked to population dynamics models for the gypsy moth to obtain a dynamic model for an individual stand or larger forested areas.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4557

Problem M1 **Maintain long-term studies of gypsy moth silvicultural practices and transfer technology to users.**

Publications

Research **Gottschalk, Kurt W.; Liebhold, Andrew M. 2000. How to reduce gypsy moth effects on central hardwood forests. In: McCabe, Richard E.; Loos, Samantha E., eds. New insights and incites in natural resource management. Transactions of the 65th North American wildlife and natural resources conference; 2000 March 24-28; Rosemont, IL. Washington DC: Wildlife Management Institute: 200-211.**

Attainment **As gypsy moth continues to move across the eastern United States, defoliation and mortality effects on forest resources will occur in these new areas, particularly the central hardwood forests, in much the same way that northeastern forests have been affected. Management of gypsy moth utilizing IPM will provide forest managers and landowners with some degree of control over these ecological and socio-economic effects. However, central hardwood forests can benefit in advance by utilizing silvicultural treatments to create healthy, mixed stands that can survive an attack by gypsy moths and minimize its effects. Initial research results show that the use of thinning treatments can be effective in minimizing mortality following gypsy moth defoliation. It is preferable to treat stands before outbreaks to maintain stands rather than to salvage dead trees after outbreaks. Use of silviculture in managing effects of gypsy moth provides the forest manager with tools other than chemical or biological insecticides for development of integrated pest management programs for gypsy moth. Finally, it is important for managers and landowners to realize that tree species will not disappear from the landscape and that the gypsy moth eventually will behave and interact with the forest more like native insects.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4558

Multiple Stress Interactions and Their Effects on Forest Health and Sustainability
Long, Robert P, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Outputs		
			Research Unit	Extramural	Cooperative
1. Determine physiological and morphological changes of trees at different stages of development.	65	2	0	0	0
2. Determine how multiple interacting stressors (abiotic and biotic agents) affect tree health.	453	2.4	3	1	0
3. Determine interacting roles of nutrition and site factors on tree declines and regeneration problems.	291	1.4	3	0	0

NORTHEASTERN RESEARCH STATION
Research Unit NE-4558

Problem 1 **Determine physiological and morphological changes of trees at different stages of development.**

Publications

Attainment **There is no progress to report this period.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4558

Problem 2 Determine how multiple interacting stressors (abiotic and biotic agents) affect tree health.

Publications

Research McQuattie, Carolyn J.; Long, R.P. 2001. Trace metal detection by x-ray microanalysis in vascular cells of roots and leaves from field-grown sugar maple seedlings. In: Bailey, G.W.; Price, R.L.; Voelkl, E.; Musselman, I.H., eds. Proceedings Microscopy and microanalysis 2001, Microscopy Society of America 59th annual meeting. 2001 August 5-9; Long Beach, CA. New York, NY: Springer-Verlag: 996-997.

McQuattie, Carolyn J.; Schier, George A. 2001. Morphological and anatomical responses of pitch pine mycorrhizae to environmental pollutants. Ohio Journal of Science. 101(1): A-46. Abstract.

Schier, George A.; McQuattie, Carolyn J. 2000. Effect of manganese on endomycorrhizal sugar maple seedlings. Journal of Plant Nutrition. 23(10): 1533-1545.

Extramural Sundaram, S.; Kim, S.J.; McQuattie, C.J.; Hiremath, S.T.; Podila, G.K.. Isolation and characterization of a symbiosis-regulated ras from the ectomycorrhizal fungus *Laccaria bicolor*. Molecular Plant-Microbe Interactions. 14(5): 618-628.

Attainment Sugar maple seedlings do not persist in the forest understory in northern Pennsylvania. One factor that may affect seedling survival is high soil Mn concentrations that occur in some low pH soils. To evaluate the potential role of manganese (Mn) toxicity in growth and survival of sugar maple (*Acer saccharum* Marsh.) seedlings, one-year-old seedlings inoculated with vesicular-arbuscular mycorrhizal (VAM) fungi and growing in sand-vermiculite-peat moss medium were irrigated for 7 weeks with nutrient solution (pH 5) containing 0.1 (control), 1, 2, 4, 8, or 16 mg/L Mn. Total seedling dry weight was negatively correlated with Mn, becoming significantly different from the control at 2 mg/L Mn. Stem and root dry weight were reduced by lower Mn levels than leaf dry weight. Except for a reduction of P in the roots, Mn had little effect on the concentration of other nutrient elements in the roots or leaves. Mn toxicity symptoms appeared in the leaves as small discrete chlorotic spots that began to appear at 1 mg/L Mn.

In another study, field-grown sugar maple seedlings were sampled in northern Pennsylvania and analyzed using transmission electron microscopy (TEM) and energy dispersive X-ray analysis (EDX). These samples revealed accumulation of electron dense areas in roots that were primarily composed of Mn. Manganese was complexed with small amounts of Ca and S indicating primary complexing compounds may be organic molecules (providing electron-density), which serve metabolic functions in the foliage. Additional research in native soils under field conditions is needed to understand the role of Mn in sugar maple regeneration failure.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4558

Problem 3 Determine interacting roles of nutrition and site factors on tree declines and regeneration problems.

Publications

Research Long, R.P.; Horsley, S.B.; Lilja, P.R.; Hall, T.J. 2000. Base cation nutrition and sugar maple health on the Allegheny Plateau. In: 2000 annual meeting of the American Society of Agronomy, Crop Science Society of America, Soil Science of America; 2000 November 5-9; Minneapolis, MN. Madison, WI: American Society of Agronomy: 338. Abstract.

Long, Robert P.; Horsley, Stephen B.; Bailey, Scott W.; Hallett, Richard A. 2001. Sugar maple growth in relation to health, glaciation and foliar nutrition in northern Pennsylvania and southern New York. In: Keeping all the parts: preserving, restoring & sustaining complex ecosystems: Washington, DC: 86th annual meeting; Ecological Society of America: Ecological Society of America; 2001 August 5-10; Madison, WI. 144. Abstract.

Rebbeck, Joanne; Gottschalk, Kurt W.; Scherzer, Amy J. 2001. How differently do seedlings of *Quercus alba*, *Q. prinus* and *Q. rubra* respond to low light intensities created by shading? In: Keeping all the parts: preserving, restoring & sustaining complex ecosystems, Ecological Society of America; 86th annual meeting, 2001 August 5-10; Madison, WI. Washington, DC: Ecological Society of America: 184. Abstract.

Cooperative Hallett, R.A.; Bailey, S.W.; Horsley, S.B.; Long, R.P. 2000. Cation nutrition: impacts on sugar maple in the northeastern United States. In: 2000 annual meeting of the American Society of Agronomy, Crop Science Society of America, Soil Science Society of America; 2000 November 5-9; Minneapolis, MN. Madison, WI: American Society of Agronomy: 348. Abstract.

Hallett, R.A.; Bailey, S.W.; Horsley, S.B.; Long, R.P.; Hall, T.J. 2000. Sugar maple health in the northeastern United States: cation nutrition and defoliation stress. In: NADP proceedings 2000-01: ten years after the clean air act amendments: Adirondacks in the balance; 2000 October 17-20; Saratoga Springs, New York [Place of publication unknown]: [Publisher unknown]: 35. Abstract.

Horsley, Stephen B.; Long, Robert P.; Bailey, Scott W.; Hallett, Richard A.; Hall, Thomas J. 2000. Factors associated with the decline disease of sugar maple on the Allegheny Plateau. Canadian Journal of Forest Research. 30: 1365-1378.

Horsley, Stephen B.; Long, Robert P.; Lilja, Paul R. 2001. Effects of fence, herbicide, and lime on regeneration of sugar maple in northern Pennsylvania. In: Keeping all the parts: Preserving, restoring, and sustaining complex ecosystems, the Ecological Society of American 86th annual meeting; 2001 August 5-10; Madison, WI. Washington, DC: The Ecological Society of America: 116. Abstract.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4558

Attainment Results of a major study to identify potential causal factors associated with sugar maple, *Acer saccharum* Marsh., decline in northern Pennsylvania revealed a significant interaction between nutrition and defoliation. Sugar maple stands on unglaciated soils and on upper slope landscape positions such as summits, shoulders, or upper backslopes are the most likely to have low amounts of foliar cations, particularly magnesium and calcium. Sugar maple decline is incited on sites like these when stands are defoliated two or more times in the past ten years. Tree-ring analysis of sugar maple growth on these sites revealed growth on unglaciated upper slopes was significantly less than lower slope trees, and growth was positively correlated with foliar concentrations of Mg and Ca.

Fire and thinning treatments were completed this year in the Fire and Fire Surrogate study sponsored by the Joint Fire Science Program. Extensive data collection on seedling, sapling, and overstory health variables has been completed and will continue in 2002. Evaluation of fuel loads and fire injury to boles of overstory trees is underway along with assessments of logging-related injury. New research was initiated to evaluate treatment effects on mycorrhizal colonization of black oak and red maple seedlings.

In related work, artificial shading treatments (6, 18, and 25% of full sun) over two growing seasons were used with white oak, *Quercus alba* L., northern red oak, *Q. rubra* L., and chestnut oak, *Q. prinus* L. to examine differential growth and physiological responses of these species to low light environments. Both red and chestnut oak height growth increased linearly with increasing light levels, while white oak growth was unaffected by light levels. Similarly, maximum photosynthetic rate of red and chestnut oaks increased with light levels, but only in the second year of the study.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4701

Efficient Use of the Northern Forest Resource
Baumgras, John E, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Outputs		
			Research Unit	Extramural	Cooperativ e
1. Effects of silviculture and forest operations on wood quality and utilization opportunities.	456	1.6	2	3	2
2. Need to identify and evaluate opportunities for improving efficiency of resource utilization.	684	2.5	6	6	0

NORTHEASTERN RESEARCH STATION
Research Unit NE-4701

Problem 1 **Effects of silviculture and forest operations on wood quality and utilization opportunities.**

Publications

Research **Wiemann, Michael C.; Brown, John. 2001. Effects of tree size on heart/sap proportions in sugar maple. In: Forest Products Society 55th annual meeting; 2001 June 24-27; Baltimore, MD. Madison, WI: Forest Products Society: 42. Abstract.**

Wiemann, Michael C.; Wiedenbeck, Janice K. 2000. Wood color in hard maple. In: Biographies & abstracts. Forest Products Society 54th annual meeting; 2000 June 18-21; South Lake Tahoe, NV. Madison, WI: Forest Products Society: 42. Abstract.

Cooperative **Lowell, Eini C.; Thomas, Edward R.; Green, David W. 2001. Evaluation of secondary products from small-diameter western softwoods using ROMI-RIP and ROMI-CROSS. In: Forest Products Society 55th annual meeting; 2001 June 24-27; Baltimore, MD. Madison, WI: Forest Products Society: 26. Abstract.**

Luppold, William G.; Prestemon, Jeffrey P.; Baumgras, John E. 2001. A long-term analysis of hardwood lumber prices. In: Pelkki, Matthew H., ed. Proceedings of the annual meeting of the Southern Forest Economics Workers (SOFEW), hardwoods - an underdeveloped resource?; 2000 March 26-28; Lexington, KY. Monticello, AR: University of Arkansas at Monticello: 149-154.

Miller, Gary W.; Baumgras, John E. 2001. Silvicultural opportunities for commercial utilization of small trees in Appalachian hardwood stands. In: Forest Products Society 55th annual meeting; 2001 June 24-27; Baltimore, MD. Madison, WI: Forest Products Society: 26. Abstract.

Miller, Gary W.; Kochenderfer, James N.; Knibbs, James; Baumgras, John E. 2001. Vegetative conditions and management options in even-age stands on the Monongahela National Forest. In: Barras, Stan J., ed. Proceedings: national silvicultural workshop; 1999 October 5-7; Kalispell, MT. RMRS-P-19. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 40-47.

Extramural **Gazo, Rado; Wiedenbeck, Janice K. 2001. Linking forest management and site factors to tree characteristics. In: Forest Products Society 55th annual meeting; 2001 June 24-27; Baltimore, MD. Madison, WI: Forest Products Society: 50. Abstract.**

Wang, Jingxin; McNeel, Joe; Baumgras, John. 2001. A computer based time study system for timber harvesting operations. In: Wang, Jingxin; Wolford, Michelle; McNeel, Joe, eds. Proceedings of the 24th annual meeting of the Council on Forest Engineering (COFE), Appalachian hardwoods - managing change; 2001 July 15-19; Snowshoe, WV. Morgantown, WV: West Virginia University. CD-ROM.

Wiemann, Michael C.; Manchester, Steven R.; Dilcher, David L.; Wheeler, Elisabeth A. 2000. Wood anatomical characters as climate indicators. In: Biographies & abstracts. Forest Products Society 54th annual meeting; 2000 June 18-21; South Lake Tahoe, NV. Madison, WI: Forest Products Society: 42. Abstract.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4701

Attainment **Research progress in FY2001 included data collection, analyses, and presenting preliminary results from a series of studies linking site characteristics, stand attributes, and silvicultural practices to wood quality and wood utilization opportunities. With sites in Wisconsin, Ohio, Kentucky, West Virginia, Michigan, Pennsylvania, and New York, these studies will provide forest managers information for increasing production of high-quality and high-value hardwood timber. A completed study reported important links between climate, wood anatomy, and specific gravity and important attributes affecting appearance and physical and mechanical properties of hardwood timber. Additional wood quality research in progress includes:**

- 1) an investigation of the chemical and mineral origins of wood discoloration that reduce the quality and value of sugar maple lumber and veneer, and**
- 2) determining the causes of elliptical log form and its impact on material recovery, and 3) identifying the key attributes of hardwood veneer logs to better understand how silvicultural practices impact the growth of high-value veneer quality timber. A completed cooperative study provides an economic analysis of alternative roundwood bucking and sorting practices designed to increase the value and volume of products from harvested timber. Significant progress also was made on the data collection phase of a cooperative study to evaluate the impacts of expanding hardwood markets on timber harvesting practices in West Virginia. A new collaborative project was initiated with the Wood Education and Resource Center to develop a broad-based technology transfer program focused on hardwood quality and processing in a CD-ROM format.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4701

Problem 2 Need to identify and evaluate opportunities for improving efficiency of resource utilization.

Publications

Research Thomas, R. Edward; Porterfield, Elizabeth. 2000. Decision-support tools for rough mill dimension processing. Meyer, Dan A., ed. In: Proceedings: 28th annual hardwood symposium: West Virginia now-the future for the hardwood industry?; 2000 May 11-13; Davis, WV. Memphis, TN: National Hardwood Lumber Association: 65-74.

Thomas, R. Edwards; Buehlmann, Urs. 2001. Marker accuracy impact on rough dimension part yield in a hardwood furniture mill. In: Forest Products Society 55th annual meeting; 2001 June 24-27; Baltimore, MD. Madison, WI: Forest Products Society: 17. Abstract.

Wiedenbeck, Jan. 2001. Deciding between crosscut and rip-first processing. Wood & Wood Products. 106(9): 100-104.

Wiedenbeck, Jan. 2001. Factors that impact rough mill yield and value. Furniture Design & Manufacturing. 73(3): 62-67.

Wiedenbeck, Jan; Dwyer, Jack. 2000. Sawmill performance systems for industry: SOLVE 2000. Meyer, Dan A., ed. In: Proceedings: 28th annual hardwood symposium: West Virginia now-the future for the hardwood industry?; 2000 May 11-13; Davis, WV. Memphis, TN: National Hardwood Lumber Association; 19-29.

Wiedenbeck, Janice K. 2001. An update on hardwood sawmill recovery and efficiency performance levels--2001. In: Forest Products Society 55th annual meeting; 2001 June 24-27; Baltimore, MD. Madison, WI: Forest Products Society: 19. Abstract.

Cooperative Luppold, William; Baumgras, John . 2001. A regional examination of the eastern "grade" hardwood sawmilling industry. In: Pelkki, Matthew H., ed. Proceedings of the annual meeting of the Southern Forest Economics Workers (SOFEW), hardwoods - an underdeveloped resource?; 2000 March 26-28; Lexington, KY. Monticello, AR: University of Arkansas at Monticello: 8-12.

Luppold, William; Baumgras, John. 2000. The changing structure of the hardwood lumber industry with implications on technology adaptation. In: Meyer, Dan A., ed. Proceedings: 28th annual hardwood symposium: West Virginia now--the future for the hardwood industry?; 2000 May 11-13; Davis, WV. Memphis, TN: National Hardwood Lumber Association: 89-94.

Luppold, William; Baumgras, John; Barrett, George. 2001. Characteristics of the eastern "grade" hardwood sawmilling industry. Forest Products Journal. 50(9): 23-27.

Luppold, William; Baumgras, John; Barrett, George. 2001. Utilization of the eastern hardwood resource by the hardwood sawmilling industry. Northern Journal of Applied Forestry. 18(2): 37-41.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4701

- Extramural** **Bond, Brian H.; Hamner, Peter C. 2001. The effect of precision end trimming on dry kiln capacity, lumber degrade, and roughmill yields. In: Forest Products Society 55th annual meeting; 2001 June 24-27; Baltimore, MD. Madison, WI: Forest Products Society: 20. Abstract.**
- Buehlmann, Urs; Thomas, R. Edward. 2000. Simulation software validation using real data. In: Zhang, Guangming; Sullivan, William G.; Ahmad, M. Munir, eds. Proceedings: 10th international conference on flexible automation and intelligent manufacturing. Vol. 1; 2000 June 26-28; College Park, MD. College Park, MD: University of Maryland: 459-468.**
- Buehlmann, Urs; Thomas, R. Edward. 2000. Validation of rip-first roughmill yield optimization software. In: Biographies & abstracts. Forest Products Society 54th annual meeting; 2000 June 18-21; South Lake Tahoe, NV. Madison, WI: Forest Products Society: 12. Abstract.**
- Buehlmann, Urs; Thomas, R. Edward. 2001. Lumber yield optimization software validation and performance review. Robotics and Computer Integrated Manufacturing. 17: 27-32.**
- Hamner, Peter C.; Bond, Brian H.; Wiedenbeck, Janice K. 2001. The effect of lumber length on part yields in gang-rip-first roughmill operations. In: Forest Products Society 55th annual meeting; 2001 June 24-27; Baltimore, MD. Madison, WI: Forest Products Society; 20. Abstract.**
- Xiaoqiu, Zuo; Mitchell, Philip H.; Thomas, R. Edward. 2001. Optimizing gang-ripsaw fixed-blade arbor spacings to improve roughmill conversion efficiency. In: Forest Products Society 55th annual meeting; 2001 June 24-27; Baltimore, MD. Madison, WI: Forest Products Society: 45. Abstract.**
- Attainment** **NE-4701's primary and secondary processing research is developing information and tools that help the hardwood industry better utilize the hardwood resource, moderate the growing demands on the hardwood resource, and sustain rural forest-based economies. Progress on NE-4701's hardwood sawmill research includes evaluation of precision end trimming of hardwood lumber, testing applications of real-time process controls to improve lumber recovery, developing a viable system for continuous improvement studies, and modeling relationships between internal and external log defect attributes. Cooperative research initiated includes an evaluation of the impacts of modern sawmilling technology on production efficiency for different species, sizes, and grades of logs, and the development of computer-based algorithms for detecting external defects from scanned sawlog images. Research completed in the area of secondary processing - conversion of lumber to finished products - has determined that significant gains in lumber yield are possible using integrated optimization techniques provided by the unit's ROMI-RIP software. Software also has been developed to determine roughmill saw arbor configurations that minimize lumber waste. Research progress includes:**
- 1) analysis of variations in lumber dimensions between lumber grades and mills to provide information for improved analysis and scheduling lumber of processing operations, and**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4701

Attainment

- 2) **developing defect marking guidelines to improve lumber conversion efficiency. New initiatives include a cooperative study to improve utilization and marketing of low-quality lumber, and a collaborative project with the Wood Education and Resource Center to improve the transfer of the unit's roughmill simulation software technology to the hardwood industry.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4751

Forest Engineering Research-Systems Analysis to Evaluate Alternative Harvesting Strategies
LeDoux, Chris B, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Outputs		
			Research Unit	Extramural	Cooperative
1. Inadequate management planning models for forest operations and forest product transportation.	116	.5	1	1	1
2. Lack of complete synthesis on all aspects of the forest operations process, selection of the harvesting process, multiproduct harvesting, loss caused by log damage and other procedures.	117	.5	1	0	0

NORTHEASTERN RESEARCH STATION
Research Unit NE-4751

- Problem 1** **Inadequate management planning models for forest operations and forest product transportation.**
- Publications**
- Research** **LeDoux, Chris B. 2000. Matching skidder size to wood harvested to increase hardwood fiber availability: a case study. Forest Products Journal. 50(10): 86-90.**
- Cooperative** **LeDoux, Chris B.; Sendak, Paul E.; McWilliams, William H.; Huyler, Neil; Malecek, Thomas; Muzzey, Worthen; Jones, Toni. 2001. Timber supply and demand assessment of the Green and White Mountain National Forests' market area. In: Gen. Tech. Rep. NE-280. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 19.**
- Extramural** **Wang, Jingxin; LeDoux, Chris B. 2001. Modeling ground-based timber harvesting systems using computer simulation. In: Proceedings of 23rd annual meeting of Council on Forest Engineering; 81st annual meeting of Canadian Woodlands Forum; 2000 September 11-13; Kelowna. BC. Kelowna, BC: Council of Forest Engineering: CD-ROM.**
- Attainment** **A study was conducted that addressed the timber supply and demand situation for the Green and White Mountain National Forests' Market Area. The study used USDA FIA inventory data, a stump-to-mill logging cost estimation model, and contemporary levels of market demand and prices for wood products in that region. Economic sustainability was evaluated under regeneration, partial cut, and diameter limit harvests. Results suggest that the current supply and demand levels are economically sustainable for about the next 45 years for sawtimber and 67 years for pulpwood. The results should be valuable to forest planners and managers. Results of this research have been presented to resource managers, policy makers, loggers, and other researchers through presentations, symposia, and other technology transfer efforts.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4751

Problem 2 **Lack of complete synthesis on all aspects of the forest operations process, selection of the harvesting process, multiproduct harvesting, loss caused by log damage and other procedures.**

Publications

Research **LeDoux, Chris B.; Huyler, Neil K. 2000. Cost comparisons for three harvesting systems operating in northern hardwood stands. Res. Pap. NE-715. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 19.**

Attainment **Studies were conducted to develop and compare the costs and productivity of alternative harvesting systems for Eastern hardwoods. Results from one study show the applicability of small and large cut-to-length systems. The second study compared the cost and productivity of three alternative harvesting systems: a cable yarder, a small tractor, and a cut-to-length system. Results from the second study include a matrix of applicability to meet BMP/AMPS guidelines. The results should be valuable to forest planners and managers. Results of this research have been presented to resource managers, policy makers, loggers, and other researchers through presentations, symposia, and other technology transfer efforts.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4801

Forest Inventory and Analysis
Scott, Charles T, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Outputs		
			Research Unit	Extramural	Cooperative
1. Conduct periodic forest resources inventories and evaluations.	3,940	.8	12	0	2
2. Conducting special analyses of specific resource issues and concerns.	1,160	3.5	3	0	0

NORTHEASTERN RESEARCH STATION
Research Unit NE-4801

Problem 1 **Conduct periodic forest resources inventories and evaluations.**

Publications

Research

Alerich, Carol L. 2000. Forest statistics for Rhode Island: 1985 and 1998. Resour. Bull. NE-149. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 104.

Alerich, Carol. 2000. Forest statistics for Connecticut: 1985 and 1998. Resour. Bull. NE-147. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 104.

Alerich, Carol. 2000. Forest statistics for Massachusetts: 1985 and 1998. Resour. Bull. NE-148. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 104.

Frieswyk, Thomas; Widmann, Richard. 2000. Forest statistics for New Hampshire: 1983 and 1977. Resour. Bull. NE-146. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 130.

Frieswyk, Thomas; Widmann, Richard. 2000. Forest statistics for Vermont: 1983 and 1997. Resour. Bull. NE-145. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 130.

Jenkins, Jennifer; Birdsey, Richard A.; Murdoch, Peter; Hom, John. 2001. Integrated environmental monitoring and assessment: In: Keeping all the parts: preserving, restoring, and sustaining complex ecosystems. The Ecological Society of America 86th annual meeting; 2001 August 5-10; Madison, WI. Washington, DC: The Ecological Society of America. Abstract.

McWilliams, William H. 2001. An inventory of Pennsylvania's forests: the need for timely information. Pennsylvania Forests. 92(2): 18-19.

McWilliams, William H. 2001. Chapter 14: Forest inventory and monitoring information for New York. In: Adams, Morton S., ed. Catskill ecosystem health: proceedings of a symposium; 1999 October 22-22; Delhi, NY. Gen. Tech. Rep. NC-212. Fleischmanns, NY: Purple Mountain Press: 191-201.

Scott, Charles T. 2000. Pennsylvania forests: a new inventory. Pennsylvania Forests. 91(3): 15.

Widmann, Richard H. 2001. forests in the Green Mountain state: a half-century of change. NE-INF-142-01. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 8.

Widmann, Richard H. 2001. The granite state's forests: trends in the resource. NE-INF-141-00. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 4.

Widmann, Richard H. 2001. Trends in Connecticut's forests: a half-century of change. NE-INF-143-01. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 4.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4801

Cooperative **Griffith, Douglas M.; Laustsen, Kenneth M. 2001. Second annual inventory report on Maine's Forests. August, ME: Maine Department of Conservation, Maine Forest Service. 42p. Available at: www.state.me.us/doc/mfs/pubs.htm.**

LeDoux, Chris B.; Sendak, Paul E.; McWilliams, William H.; Huyler, Neil; Malecek, Thomas; Muzzey, Worthen; Jones, Toni. 2001. Timber supply and demand assessment of the Green and White Mountain National Forests' market area. In: Gen. Tech. Rep. NE-280. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 19.

Miles, Patrick D.; Brand, Gary J.; Alerich, Carol L.; Bednar, Larry F.; Woudenberg, Sharon W.; Glover, Joseph F. 2001. The forest inventory and analysis database: database description and users manual version 1.0. In: Gen. Tech. Rep. NC-218. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 130.

Attainment **The primary role of Forest Inventory and Analysis is to assess the status and trends in the forest resources of the 13 Northeastern states. Detailed statistical tables were published for Connecticut, Massachusetts, New Hampshire, Rhode Island and Vermont. Results were also provided to a more general audience in the form of brochures for Connecticut, New Hampshire and Vermont. The forests have been maturing with sawtimber stands predominating and with far fewer acres of seedling and sapling stands. The total forest area is remaining stable - the result of losses of forest land to urbanization being offset by reversion of farmland. The volume of timber removed in Southern New England is primarily the result of land use change rather than harvesting for timber.**

FIA has shifted from periodic measurements of each state to an annual survey (visiting a portion of plots each year) in three states: Maine - 1999, Pennsylvania - 2000 and Ohio - 2001. In partnership with the Maine Forest Service, the results of the 1999 and 2000 surveys were published. The results have been vital in the development of policies for and the management of the forest resources of Maine - the most heavily forested state in the nation.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4801

Problem 2 **Conducting special analyses of specific resource issues and concerns.**

Publications

Research **King, S.; Lister, A.J.; Hoppus, M. 2000. A comparison of kriging and cokriging for mapping forest volume in Connecticut. In: Third annual southern forestry GIS conference; 2000 October 10-13; Athens, GA. Athens, GA. University of Georgia: Center for Continuing Education: On CD Rom.**

King, Susan Lynn. 2000. Mapping pockets of high-value black cherry trees in Pennsylvania. Compiler. 16(1): 14-24.

Riemann, R.; Lister, A.J. 2001. Stochastic simulation for mapping ground inventory variables: creating and using the FIA species distribution maps. In: Pattern, process and hierarchy: 16th annual symposium of the International Association for Landscape Ecology; 2001 April 25-29; Tempe, AZ. [Place of publication unknown]: International Association for Landscape Ecology. Poster abstract.

Cooperative **Jenkins, Jennifer C.; Birdsey, Richard A.; Pan, Yude. 2000. Biomass and NPP estimation for the mid-Atlantic region (USA) using plot-level forest inventory data. Ecological Applications. 11(4): 1174-1193.**

Luppold, William G.; McWilliams, William H. 2000. Issues affecting the interpretation of eastern hardwood resource statistics. Forest Products Journal. 50(4): 21-24.

Attainment **As interest grows in quantification of global carbon cycles, process model predictions of forest biomass and net primary production (NPP) are being developed at an accelerating rate. Models can provide useful predictions at large scales, but it has been difficult to evaluate their performance. Using Forest Inventory and Analysis (FIA) data, we developed estimates of forest biomass and NPP for the mid-Atlantic region of the United States at a scale appropriate for comparison with model predictions. Plot- and tree-level forest inventory data from a subset of plots were used with biomass regression equations to calculate maximum current biomass and NPP values. Estimates at the plot level were aggregated by forest type and to the 0.5° x 0.5° scale for analysis and comparison with process-model predictions. By describing upper and lower bounds on reasonable biomass and NPP values for closed-canopy forests, these FIA-derived estimates provide a foundation for model comparison and continued model development.**

Geostatistical methods were investigated for use in producing localized estimates of forest inventory attributes at state and regional scales. A variety of methods, including several parametric and nonparametric, univariate and multivariate geostatistical procedures (e.g., kriging) were compared and contrasted with results obtained from conventional and non-geostatistical methods (e.g., multiple linear regression) with respect to their ability to make accurate predictions of forest resource attributes between FIA plot locations. Our results indicate that while geostatistical methods show a great deal of promise, it is clear that additional refinements are required before high accuracies are obtained. The results also indicate that there are often dramatic improvements in accuracy of prediction when either satellite imagery, digital elevation-derived data, or a combination of the two are included with plot data in the estimation procedure.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4803

Economics of Eastern Forest Use
Hansen, Bruce G, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Outputs		
			Research Unit	Extramural	Cooperative
1. Information is needed on all markets for roundwood and on principal consumers of hardwood lumber and wood fiber on a continuing basis.	991	2.5	16	0	0
2. Research is needed on viable, market-based, value-added product opportunities that improve use of forest resource.	235	.5	9	4	0

NORTHEASTERN RESEARCH STATION
Research Unit NE-4803

Problem 1 Information is needed on all markets for roundwood and on principal consumers of hardwood lumber and wood fiber on a continuing basis.

Publications

Research Adair, Craig; Schuler, Al. 2001. Chapter 11 - Secondary processed wood products markets, including engineered wood products. Forest Products Annual Market Review. LIV(ECE/TIM/BULL/54/3): 130-132.

Emanuel, David M.; Rhodes, Carol. 2001. Bulletin of hardwood market statistics: 2000. Res. Note NE-373. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 22.

Emanuel, David; Rhodes, Carol. 2001. Bulletin of hardwood market statistics: first half 2000. Res. Note NE-372. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 22.

Hyldahl, Carol A.; Hansen, Bruce G.; West, Cynthia D. 2001. Hardwood chips: production, consumption, and exports. In: Pelkki, Matthew H., ed. Proceedings of the annual meeting of the Southern Forest Economics Workers (SOFEW), hardwoods - and underdeveloped resource?; 2000 March 26-28; Lexington, KY. Monticello, AR: University of Arkansas at Monticello: 155-159.

Hyldahl, Carol A.; Hansen, Bruce G.; West, Cynthia D. 2001. Hardwood chips: production, consumption, and exports. Tech. Pap. 01-P-11. Rockville, MD: Forest Resources Association: 7.

Schuler, A.; Adair, C. 2000. Engineered wood products--global perspective. Engineered Lumber Trends. 4(12): 1, 5-6, 8.

Schuler, Al. 2000. Engineered wood products: a growing factor in hardwood fiber consumption. In: Meyer, Dan A., ed. Proceedings: 28th annual hardwood symposium: West Virginia now-the future for the hardwood industry?; 2000 May 11-13; Davis, WV. Memphis, TN: National Hardwood Lumber Association: 1-6.

Schuler, Al. 2000. Nonresidential construction opportunities for engineered products. Woodwards. (November): 14, 17.

Schuler, Al. 2001. 2001 lumber market outlook. Woodwards. January/February: 24-25.

Schuler, Al. 2001. Chapter 2 - Economic factors affecting forest products markets in 2000 and early 2001. Forest Products Annual Market Review. LIV(ECE/TIM/BULL/54/3): 9-10.

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NORTHEASTERN RESEARCH STATION
Research Unit NE-4803

- Research** Schuler, Al; Adair, Craig. 2001. Continued growth for glulam, I-beam, LVL. *PanelWorld*. 42(5): 6, 66.
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- Schuler, Al; Bumgardner, Matt; Hansen, Bruce; Luppold, Bill. 2001. Implications of the rising use of hardwoods in OSB. *Engineered Wood Journal*. 4(2): 29-32.
- Extramural** Bejune, Jeffery John. 2001. Wood use trends in the pallet and container industry: 1992-1999. Blacksburg, VA: Virginia Polytechnic Institute and State University: 121p. M.S. thesis.
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- Olah, David F. 2000. Wood material use in the U.S. cabinet industry: 1999-2001. Blacksburg, VA: Virginia Polytechnic Institute and State University: 108p. M.S. thesis.
- Olah, David; Smith, David; Hansen, Bruce. 2000. Wood material use in the U.S. cabinet industry: 1999-2001. Blacksburg, VA: Virginia Polytechnic Institute and State University, Center for Forest Products Marketing. 27p.
- Attainment** Despite production of a record number of new pallets in 1999 (429 million), hardwood use declined by 2.6% from 4.5 billion board feet in 1995 to 4.4 billion board feet in 1999. In contrast, softwood use increased nearly 20%. Most significant was the increase in the use of recycled pallets and pallet parts. Recovered wood from discarded and recycled pallets accounted for the equivalent of 4.1 billion board feet, an increase of nearly 80% since 1995. Continued growth in the use of recycled materials may seriously affect this important market for low-grade hardwood lumber.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4803

Attainment **Wood furniture imports now account for the equivalent of roughly 50% of U.S. domestic shipments, nearly double their share in 1992. Lesser increases are now being seen in imports of wood office, upholstered, and kitchen cabinets as well. Project scientists are looking at the competitive position of the U.S. furniture industry with hopes of developing new business and manufacturing paradigms. Loss of U.S. manufacturing overseas not only directly affects domestic furniture manufacturers, but it affects those supplying these industries as well. Initial activities in this area have been met with considerable industry and state support.**

During the late 1990's Asia endured one of the worst economic recessions in modern times. As a consequence, U.S. exporters saw shipments of hardwood lumber to the region decline dramatically. Closer examination by project scientists revealed that the Asia of today is far different than that of just a few years ago. China/Hong Kong is now the dominant player accounting for over half of all exports to the region.

Activities related to the unit's newly assumed responsibilities under TPO (Timber Product Output) have gotten off to a good start. We are in the process of completing an interim survey of New York and collecting data for West Virginia.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4803

Problem 2 Research is needed on viable, market-based, value-added product opportunities that improve use of forest resource.

Publications

Research Bumgardner, Matthew S.; Bush, Renate; West, Cynthia D. 2001. Product development in large furniture companies: a descriptive model with implications for character-marked products. *Wood and Fiber Science*. 33(2): 301-313.

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Hansen, Bruce; Araman, Phil; West, Cindi; Schuler, Al. 2001. Hardwood timber markets-a focus on small diameter. *Forestry and Forest Products International*. 1-2.

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Palmer, A. Jefferson, Jr.; Hansen, Bruce G.; West, Cynthia D. 2000. Pallet Costing System Version 1.0 for Microsoft Windows. In: Meyer, Dan A., ed. *Proceedings: 28th annual hardwood symposium: West Virginia now-the future for the hardwood industry?*; 2000 May 11-13; Davis, WV. Memphis, TN: National Hardwood Lumber Association: 78-80.

Schuler, Al. 2001. Using product life cycles and S-curves to adjust to technology, markets and competition. *Woodwards*. June/July: 40, 42-43.

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Extramural Gaston, Christopher; Kozak, Robert; O'Connor, Jennifer; Fell, David. 2001. Potential for increased wood-use in N.A. non-residential markets. Proj. No. 2711. Vancouver, BC: Forintek Canada Corp. 119p.

Irland, Lloyd C.; Rice, Robert. 2001. Hardwood log exports from selected northeastern states to Canada. Final report. [Place of publication unknown]: [Publisher name unknown]. 108p.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4803

Extramural Rice, Patricia; Bumgardner, Matthew S.; West, Cynthia D.; Rice, Robert W. 2001. Grading standards for character-marked maple: perspectives of primary and secondary manufacturers. In: Forest Products Society 55th annual meeting; 2001 June 24-27; Baltimore, MD. Madison, WI: Forest Products Society: 21. Abstract.

West, Cindi. 2000. Study reveals consumers accept character marks, 2000, November, Des Plaines, IL. 56-61.

Attainment A study, using a sample of over 250 undergraduate students, conducted to determine the psychological images associated with different wood species used in furniture found that the major wood species used in secondary products are not equal in terms of the meaning they convey to products. Appearance-based evaluations tended to rate woods similarly based on general color-darker woods were rated as expensive, formal, old-fashioned and stately, while lighter colored woods were rated inexpensive, casual, modern and modest. Respondents generally overrated their ability to identify the wood species and had most difficulty identifying mahogany and maple. Oak exhibited the most contradiction between evaluations based on perception verses those based on appearance. By having a better understanding of the images associated with different wood species, product design and promotion can be targeted at more desirable products and consumer preferences.

Allowing discolor and mineral stain that occurs in maple to be used in finished furniture products has been suggested as one way to increase supplies available to the industry. It also has been suggested that existence of "standardized grades" would do much to expedite increased use by simplifying and clarifying negotiations between buyer and seller. Results of survey found little interest in such grades. Nearly half of the respondents indicated that such grades would not be helpful to them while only a fourth thought grades would be helpful.

We continue to serve our many clients through development of computer software, short articles on current issues, and consultations.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4805

The influence of markets on the sustainability of eastern hardwood forests.
 Luppold, William George, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Outputs		
			Research Unit	Extramural	Cooperative
1. Examine current impact of different localized market situations on forests and provide information that will allow policy makers, industry and others to assess forest sustainability under current market induced disturbance regimes.	108	7	0	1	6
2. Develop procedures to predict how future market induced disturbance will change species distribution, timber quality, and sustainability of specific ecosystems and examine how adaptive technology will influence these changes.	47	3	0	0	1

NORTHEASTERN RESEARCH STATION
Research Unit NE-4805

Problem 1 Examine current impact of different localized market situations on forests and provide information that will allow policy makers, industry, and others to assess forest sustainability under current market induced disturbance regimes.

Publications

- Cooperative** Luppold, William G.; McWilliams, William H. 2000. Issues affecting the interpretation of eastern hardwood resource statistics. *Forest Products Journal*. 50(4): 21-24.
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- Luppold, William; Baumgras, John. 2000. The changing structure of the hardwood lumber industry with implications on technology adaptation. In: Meyer, Dan A., ed. *Proceedings: 28th annual hardwood symposium: West Virginia now--the future for the hardwood industry?*; 2000 May 11-13; Davis, WV. Memphis, TN: National Hardwood Lumber Association: 89-94.
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- Extramural** Dasmohapatra, Sudipta; Smith, Paul M.; O'Connell, Tracy; Luppold, William G. 2001. Hardwood sawmill industry in Pennsylvania. In: *Forest Products Society 55th annual meeting*; 2001 June 24-27; Baltimore, MD. Madison, WI: Forest Products Society: 46. Abstract.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4805

Attainment The hardwood resource of the eastern United States has been formed by continued human disturbance with the greatest disturbances emanating from harvesting activities (market induced disturbance) over the last 150 years. Understanding how demand for forest products influence forest composition is necessary in the evaluation of the impact of market based disturbance. Forest inventory data is critical in the analysis of the influence of markets on the forest resource. While this data is accurate, it is easy to misinterpret, therefore, a clear understanding of this data as it applies to the research in market induced disturbance must be established. Another important component to understanding the impact of markets on the resource is assessing the type of material the market has required and the type of timber these markets require. Hardwood roundwood is consumed by producers of hardwood lumber, pulpwood, and engineered wood products. Although hardwood lumber has historically been the largest user of hardwood roundwood, use of hardwood for pulping has surpassed use of hardwood for lumber production over the last decade. However, while southern hardwood pulpwood production is much greater than hardwood sawtimber demand, hardwood sawmills are still the major user of roundwood in the northeast. The design of sawmills influences the type of log that can be economically processed. Whereas mills with low fixed costs can processes low quality logs, such mills cannot recover enough value from high grade logs to processes them economically. Conversely, mills designed to processes high value logs cannot profitably process low value logs. Ongoing research is being conducted to understand differences in sawmill design within and between regions in order to assess what portion of the resource will be demanded by these mills. Another consumer whose use of hardwood roundwood has increased over the last decade is oriented strand board manufacturers.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4805

Problem 2 **Develop procedures to predict how future market induced disturbance will change species distribution, timber quality, and sustainability of specific ecosystems and examine how adaptive technology will influence these changes.**

Publications

Cooperative **Luppold, William G.; Prestemon, Jeffrey P.; Baumgras, John E. 2001. A long-term analysis of hardwood lumber prices. In: Pelkki, Matthew H., ed. Proceedings of the annual meeting of the Southern Forest Economics Workers (SOFEW), hardwoods - an underdeveloped resource?; 2000 March 26-28; Lexington, KY. Monticello, AR: University of Arkansas at Monticello: 149-154.**

Attainment **The hardwood resource of the eastern United States has been influenced by continued human disturbance with the greatest disturbances emanating from harvesting activities (market induced disturbance) over the last 150 years. Just as past market induced disturbances have influenced the composition and structure of today's forests, similar activity is influencing the forests of tomorrow. Over the last 50 years the hardwood market has been inconsistent in the demand and valuation of specific species. In the early 1950's the demand and price of red oak were low causing its proportional representation in the forests composition to increase. However, by the 1980's red oak demand was high and by the 1990's harvest of red oak exceeded growth in many areas of the east. In order to better anticipate these shifts research has focused on understanding the variations in the prices of specific hardwood species over time. Another way one can examine the impact of markets on the resource is to assess current and future utilization of a species relative to its volume in the resource. Analysis of market trends indicate that high value species such as red oak and black cherry are being relatively overutilized while red maple (a lower valued species) is being underutilized by the hardwood lumber industry. However, yellow-poplar (a low value and abundant species) has found to be overutilized in many area of the east suggesting that factors other than market valuation may be contributing to volume of a species used by the hardwood sawmilling industry. Other species not being utilized by the sawmilling industry such as sweet gum appear to be utilized in the production of industrial and construction veneers or engineered wood products. Information of long term price trends and relative utilization rates are building blocks for a system to predict future changes in types of species and roundwood utilization and thus future changes in forest composition and structure.**

NORTHEASTERN RESEARCH STATION
Research Unit NE-4952

Effects of Urban Forests and their Management on Human Health and Environmental Quality
Nowak, David J, Project Leader

FY 2001 Research Attainments
Research Unit Summary

Problem Number and Title	Current Funding (\$1,000)	Current Staffing (Scientist years)	Research Outputs		
			Research Unit	Extramural	Cooperative
1. Measure the structure and health of urban forests, their variation across the United States, and change through time	150	.6	2	0	3
2. Assess how urbanization is affecting the structure, function, and health of forests within and around urban areas.	431	2	8	4	1
3. Quantify the net effects of urban forest structure and its management on the environment and human health.	227	2	9	3	1
4. Develop management tools and guidelines that can be used to optimize the environmental benefits of urban forests to improve human health and environmental quality in and around urban areas.	100	.3	0	0	0

NORTHEASTERN RESEARCH STATION
Research Unit NE-4952

Problem 1 **Measure the structure and health of urban forests, their variation across the United States, and change through time.**

Publications

Research **Myeong, Soojeong; Hopkins, Paul; Brock, Robert H.; Nowak, David. 2001. Urban cover classification using digital, high resolution aerial imagery. In: Proceedings of the American Society for Photogrammetric and Remote Sensing 2001 Annual Conference; 2001 April 23-27; St. Louis, MO. Bethesda, MD: American Society for Photogrammetric and Remote Sensing: On CD-Rom.**

Nowak, David J.; Pasek, Judith E.; Sequeira, Ronaldo A.; Crane, Daniel E.; Mastro, Victor C. 2001. Potential effect of *Anoplophora glabripennis* (Coleoptera: Cerambycidae) on urban trees in the United States. Journal of Economic Entomology. 94(1): 116-122.

Cooperative **Dwyer, John F.; Childs, Gina M.; Nowak, David J. 2000. Forestry in urban and urbanizing areas of the United States: connecting people with forests in the 21st century. In: Krishnapillay, Baskaran; Soepadmo, E.; Arshad, Najib Lofty, eds. Forests and society: the role of research: XXI IUFRO World Congress. Sub-plenary sessions, vol.1; 2000 August 7-12; Kuala Lumpur, Malaysia. Kuala Lumpur, Malaysia: Malaysian XXI IUFRO World Congress Organizing Committee: 629-637.**

Dwyer, John F.; Nowak, David J.; Noble, Mary Heather; Sisinni, Susan M. 2000. Connecting people with ecosystems in the 21st century: an assessment of our nation's urban forests. Gen. Tech. Rep. PNW-GTR-490. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 483.

Hom, J.; Nowak, D.; Golub, D.; Heisler, G.; Grimmond, S.; Offerle, B. 2001. Studies on carbon flux in urban forests at the Baltimore ecosystem study LTER. In: Abstracts of scientific papers and posters presented at the Global Change Open Science Conference, Challenges of a changing earth; 2001 July 10-13; Amsterdam, The Netherlands. [Place of Publication unknown]: [Publisher name unknown]: [Page number unknown]. Abstract.

Nowak, David J.; Noble, Mary H.; Sisinni, Susan M.; Dwyer, John F. 2001. Assessing the US urban forest resource. Journal of Forestry. 99(3): 37-42.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4952

Attainment The first national assessment of urban forests was published and will provide background information to help guide future policies and programs for sustaining the structure, functions and benefits of urban forests. Urban forest cover is shown to be large and expanding with urban areas doubling in size between 1969 and 1994. Urban areas currently occupy about 3.5% of the coterminous United States and have about 3.8 billion trees that cover 27% of these areas. Data from this assessment was used to estimate the potential impact of a newly introduced Asian longhorned beetle on urban forest populations. The estimated maximum potential national urban impact of this beetle is a loss of 34.9% of total canopy cover, 30.3% tree mortality (1.2 billion trees) and value loss of \$669 billion. New remote sensing methods have also been developed to map tree cover in urban areas at a relatively high level of resolution (sub-meter). These types of high-resolution urban tree cover maps are easily incorporated into geographic information systems and can significantly aid in urban forest management and quantify the impact of urban forests on human health and environmental quality.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4952

Problem 2 Assess how urbanization is affecting the structure, function, and health of forests within and around urban areas.

Publications

- Research** Band, Lawrence E.; Belt, Kenneth; Groffman, Peter; Fisher, Gary; Tenenbaum, David. 2000. Long term experimental watershed studies in the Baltimore Ecosystem Study. In: Abstracts of American Geophysical Union fall 2000 meeting; 2000 December 15-19; San Francisco, CA. EOS Suppl. 81(48):F375. Washington, DC: American Geophysical Union. F375. Poster abstract.
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- Belt, K.T.; Groffman, P.M.; Band, L.E.; Fisher, G.T.; Colosimo, M.; Readell, K.; Weber, C.S. 2001. The urban hydrologic system and water quality patterns along an urban rural gradient in the Gwynns Falls watershed, Baltimore, MD, USA. Bulletin of the North American Benthological Society. 18(1): 156-157. Presentation Abstract.
- Belt, Ken; Stack, Bill. 2000. Urban hydrologic cycle and its effect on the chemistry and biota of streams. In: Program and abstracts: Maryland Water Monitoring Council 6th annual meeting; 2000 December 1; Linthicum, MD. Baltimore, MD: Maryland Department of Natural Resources. Presentation abstract.
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- Lovett, Gary M.; Traynor, Martin M.; Pouyat, Richard V.; Carreiro, Margaret M.; Zhu, Wei-Xing; Baxter, James W. 2000. Atmospheric deposition to oak forests along an urban-rural gradient. Environmental Science and Technology. 34: 4294-4300.
- Zipperer, Wayne C.; Pickett, Steward T.A. 2001. Urban ecology: patterns of population growth and ecological effects. In: Encyclopedia of Life Sciences. London, UK: Macmillan Publishers Ltd., Nature Publishing Group. 6. Online publication available at www.els.net

NORTHEASTERN RESEARCH STATION
Research Unit NE-4952

- Cooperative** Nechodom, Mark; Rowntree, Rowan; Dennis, Nick; Robison, Hank; Goldstein, Jamie. 2000. Social, economic, and institutional assessment. In: Murphy, Dennis D.; Knopp, Christopher M.; eds. Lake Tahoe watershed assessment: volume 1. Gen. Tech. Rep. PSW-GTR-175. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 601-687.
- Extramural** Baxter, James W.; Pickett, Steward T.A.; Carreiro, Margaret M.; Dighton, John. 1999. Ectomycorrhizal diversity and community structure in oak forest stands exposed to contrasting anthropogenic impacts. *Canadian Journal of Botany*. 77: 771-782.
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- Mitchell, Myron J.; McHale, Patrick J.; Inamdar, Shreeram; Raynal, Dudley J. 2001. Role of within-lake processes and hydrobiogeochemical changes over 16 years in a watershed in the Adirondack Mountains of New York State, USA. *Hydrological Processes*. 15: 1951-1965.
- Weidel Huckstep, Ramona J. 2001. Influences of herbaceous vegetation on small mammal communities within forest stands In New York City parks. University of Missouri: M.S. Thesis. 76.
- Attainment** Particle deposition measured along an urban to rural gradient revealed that particulate concentrations declined significantly with distance from city, mostly within 45 km of the city. Deposition of inorganic nitrogen was twice as high in urban areas compared with rural environments. Dust particles had little alkalinity suggesting that alkaline aerosols were neutralized by acidic gases. It is proposed that dust emissions from New York City act like an "urban scrubber", removing acidic gases from the atmosphere and depositing them on the city as coarse particles. Excess deposition of nitrogen and pollutants could be important for nutrient budgets of forests in and near urban areas.

NORTHEASTERN RESEARCH STATION
Research Unit NE-4952

Problem 3 Quantify the net effects of urban forest structure and its management on the environment and human health.

Publications

- Research** Band, L.E.; Tague, C.L.; Groffman, P.; Belt, K. 2001. Forest ecosystem processes at the watershed scale: hydrological and ecological controls of nitrogen export. *Hydrological Processes*. 15: 2013-2028.
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- Ibarra, Myriam; Zipperer, Wayne C. 2000. Concentrated recreation. In: Dissmeyer, George E. ed. *Drinking water from forests and grasslands: a synthesis of the scientific literature*. Gen. Tech. Rep. SRS-39. Ashville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 74-80.
- Nowak, David J. 2000. Carbon storage and sequestration by urban forests in the United States. In: *Advances in terrestrial ecosystem carbon inventory, measurements, and monitoring*; 2000 October 3-5; Raleigh, NC. [Place of publication unknown]: [Publisher name unknown]: 71. Abstract.
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NORTHEASTERN RESEARCH STATION

Research Unit NE-4952

Cooperative Dwyer, John F.; Watson, Gary; Nowak, David. 2000. State of the art of research and knowledge on forestry in the USA. In: Jandl, Robert; Devall, Margaret; Khorchidi, Margarete; Schimpf, Eva; Wolfrum, Gerda; Krishnapillay, Baskaran, eds. Forests and society: the role of research: XXI IUFRO World Congress. Abstracts of group discussions, vol. 2; 2000 August 7-12; Kuala Lumpur, Malaysia. Kuala Lumpur, Malaysian XXI IUFRO World Congress Organizing Committee: 269. Abstract.

Extramural Jouraeva, Venera A. 2000. Differences in accumulation of polycyclic aromatic hydrocarbons and metals on the leaves of *Tilia euchlora* and *Pyrus calleryana*. Syracuse, NY: State University of New York, College of Environmental Science and Forestry: 101p. M.S. thesis.

Vanasselt, Wendy; Mock, Gregory. 2000. Urban ecosystems. In: World resources 2000-2001, people and ecosystems: the fraying web of life. Washington, DC: World Resources Institute: 141-145.

Voogt, J. A.; Grimmond, C.S.B. 2000. Modeling surface sensible heat flux using surface radiative temperatures in a simple urban area. *Journal of Applied Meteorology*. 39: 1679-1699.

Attainment Ultraviolet (UV) radiation is associated with a wide range of human health problems including skin cancer, cataracts, and immune deficiencies. Trees influence the amount of UV radiation reaching the ground. Analyses with a new UV model suggest that UV-B exposure for children in neighborhoods with multi-family dwellings is twice that for children in single-family dwelling neighborhoods. These results have implications for urban designs and human health.

Based on urban forest data, the best urban forest designs and management strategies to improve air quality include:

- Increase the number of healthy trees (increases pollution removal and carbon sequestration)
- Sustain existing tree cover (maintains current carbon storage and pollution removal levels)
- Maximize use of low VOC emitting trees (reduces ozone and carbon monoxide formation)
- Sustain large, healthy trees (large trees have greatest per tree effects)
- Use long-lived trees (forestalls carbon emissions from decomposition)
- Use low-maintenance trees (reduces pollutants emissions from maintenance activities)
- Reduce fossil fuel use in maintaining vegetation (reduces chemical emissions)
- Plant trees in energy conserving locations (reduces chemical emissions from power plants)
- Plant trees to shade parked cars (reduces vehicular VOC emissions)
- Supply ample water to vegetation (enhances pollution removal and temperature reduction)
- Plant trees in polluted areas or heavily populated areas (maximizes tree effects)
- Avoid pollutant sensitive species (increases tree health)

NORTHEASTERN RESEARCH STATION
Research Unit NE-4952

- Attainment**
- Utilize evergreen trees for particulate matter reduction (year-round removal of particles)
 - Utilize wood for long-term products (forestalls carbon emissions from decomposition)
 - Utilize tree materials for energy production (reduces chemical emissions from power plants)

NORTHEASTERN RESEARCH STATION
Research Unit NE-4952

Problem 4 **Develop management tools and guidelines that can be used to optimize the environmental benefits of urban forests to improve human health and environmental quality in and around urban areas.**

Publications **Attainment No progress to report this period.**

PART II: BIBLIOGRAPHY

**Northeastern Research Station
Fiscal Year 2001**

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